Program Change Request

New Proposal

Date Submitted: 12/04/23 11:44 am

Viewing: **: Chemical Engineering + Data Science, BS**

Last edit: 04/12/24 12:55 pm

Changes proposed by: Kathy Thomas-Stagg

In Workflow

1. **U Program Review**
2. **1687 Head**
3. **1434 Head**
4. **1257 Head**
5. **1992 Head**
6. **1583 Head**
7. **SOCS Head**
8. **KP Committee Chair**
9. **LP Committee Chair**
10. **KP Dean**
11. **LP Dean**
12. **KV Dean**
13. **University Librarian**
14. **COTE Programs**
15. **Provost**
16. **Senate EPC**
17. Senate
18. U Senate Conf
19. Board of Trustees
20. IBHE
21. HLC
22. DMI

Approval Path

1. 12/06/23 10:09 am
   Donna Butler (dbutler): Approved for U Program Review
2. 12/06/23 10:39 am
   Christopher Rao (cvrao): Approved for 1687 Head
3. 12/12/23 10:50

am
Elsa Gunter (egunter): Approved for 1434 Head

4. 12/12/23 11:20 am
Lee DeVille (rdeville): Approved for 1257 Head
5. 12/15/23 1:23 pm
Catherine Blake (clblake): Approved for 1992 Head
6. 12/15/23 7:54 pm
Bo Li (libo): Approved for 1583 Head
7. 12/15/23 7:59 pm
Karla Denzler (denzler): Approved for SOCS Head
8. 01/12/24 11:56 am
Ashley Hallock (ahallock): Approved for KP Committee Chair
9. 03/11/24 4:48 pm
Lisa Bievenue (bievenue): Approved for LP Committee Chair
10. 03/12/24 7:55 am
Michael Stoller (stoller4): Approved for KP Dean
11. 03/12/24 9:05 am
Catherine Blake (clblake): Approved for LP Dean

12. 03/29/24 11:08 am
    Andrea Ray (aray): Approved for KV Dean
13. 04/09/24 4:15 pm
    Claire Stewart (clairest): Approved for University Librarian
14. 04/09/24 4:17 pm
    Suzanne Lee (suzannel): Approved for COTE Programs
15. 04/10/24 10:46 am
    Brooke Newell (bsnewell): Approved for Provost
16. 04/16/24 8:56 am
    Barbara Lehman (bjlehman): Approved for Senate EPC
17. 04/19/24 11:20 am
    Barbara Lehman (bjlehman): Rollback to Senate EPC for Senate

Proposal Type

Proposal Type:
Major (ex. Special Education)

Administration Details

Official Program Name	Chemical Engineering + Data Science, BS
Diploma Title	Bachelor of Science in Chemical Engineering plus Data Science
Sponsor College	Liberal Arts & Sciences

Sponsor Department	Chemical and Biomolecular Engineering
Sponsor Name	Professor Christopher Rao, PhD
Sponsor Email	cvrao@illinois.edu
College Contact	Stephen R. Downie
College Contact Email	sdownie@illinois.edu
College Budget Officer	Michael Wellens
College Budget Officer Email	wellens@illinois.edu

List the role for rollbacks (which role will edit the proposal on questions from EPC, e.g., Dept Head or Initiator) and/or any additional stakeholders. Purpose: List here who will do the editing work if proposal needs rolled back. And any other stakeholders.

Professor Baron Peters - baronp@illinois.edu - CHBE Undergraduate Dept. Head
Kathy Thomas-Stagg - chbe-ugprogramoffice@illinois.edu - CHBE UG Program Coordinator

Does this program have inter-departmental administration?

Yes

Interdisciplinary Colleges and Departments (list other colleges/departments which are involved other than the sponsor chose above)

Please describe the oversight/governance for this program, e.g., traditional departmental/college governance. Inclusion of/roles of elected faculty committees? Inclusion of/roles of any advisory committees.

In Spring 2017, the College of Liberal Arts & Sciences submitted an Investment for Growth Proposal to "Jump Start Data Science", focusing on undergraduate data science education. Interim Provost John Wilkin supported the proposal, but called on LAS to work with three colleges (Engineering, the iSchool, and the Gies College of Business) to develop a collaborative approach to undergraduate data science at Illinois.

Those deans formed a task force (herein the "Data Science Education Task Force" or DSETF) to explore opportunities and make proposals for undergraduate data science education at Illinois. The DSETF conducted its work during academic years 2017—2018 and 2018—2019. At the core of their work was the vision that every Illinois undergraduate should have the opportunity to have a meaningful exposure to data science.

In February 2019, the four deans agreed to support a shared framework for X+Data Science majors, based on suggestions from the DSETF. The framework consisted of the following pieces.

1) A set of core competencies and common features which will be expected of X+Data science majors, together with a reference standard set of courses and activities that fulfills the data science portion of those expectations.

2) Each college can propose its own X+Data Science majors, which will be majors of that college. They may differ from the reference standard approach. When they do so, they should explain how the proposed major provides the expected competencies and features of an X+Data Science major in a manner that is appropriate for their students.

3) The deans will engage with the campus leadership to establish a Data Science Education committee. The committee will:

- Keep track of offerings related to data science to facilitate collaboration and reduce redundancy
- Facilitate the development of data science programs by connecting undergraduate data science education resources across the university
- Advise colleges on matters related to undergraduate data science education
- Review X+Data Science major proposals, commenting on how they meet the expectations for X+Data Science majors and engage collaboratively and strategically with the university's resources in data science education.

College Grainger College of Engineering

Department Computer Science

Is there an additional department involved in governance?
Yes

College Liberal Arts & Sciences

Department Mathematics

Is there an additional department involved in governance?

Yes

College Information Science, School of

Department Information Sciences

Is there an additional department involved in governance?

Yes

College Liberal Arts & Sciences

Department Statistics

Proposal Title

Effective Catalog Term: Spring 2025

Proposal Title (either Establish/Revise/Eliminate the Degree Name in Program Name in the College of XXXX, i.e., Establish the Bachelor of Science in Entomology in the College of Liberals Art and Sciences, include the Graduate College for Grad Programs)

Establish the Bachelor of Science in Chemical Engineering plus Data Science in the College of Liberal Arts and Sciences

Does this proposal have any related proposals that will also be revised during the next 6 weeks? Consider Majors, Minors, Concentrations & Joint Programs in your department. Please know that this information is used administratively to move related proposals through workflow efficiently. Example: If you are revising the BS proposal and one related concentration within the next 6 weeks, "This BS proposal (key 567) is related to the Concentration A proposal (key 145)."

Program Justification

Provide a brief justification of the program, including highlights of the program objectives, and the careers, occupations, or further educational opportunities for which the program will prepare graduates, when appropriate.

Rapid growth in digital computing power and device interconnectivity have made it possible to acquire and rapidly analyze massive amounts of data. These data science advances have already transformed commerce, social networks, and even our language, c.f. "google (v)" in Merriam-Webster. Indeed, data science is emerging as a subject of great importance in many domains of human and scholastic endeavor. There is substantial demand, both from students and from employers, for educational programs in data science. A 2017 study by researchers at IBM and Burning Glass Technologies predicts the demand for Data Scientists will grow by 28% by 2020. Enrollment in the undergraduate majors of "Statistics" and "Statistics and Computer Science," which provide students access to some of the competencies of data science, have grown by a factor of six in the last ten years.

Data science is currently transforming science and engineering, offering practical fast solutions as an alternative to first principles analyses wherever adequate data can be procured. As these technologies become more prevalent in the engineering profession, we as educators have a duty to prepare our students to use them effectively, safely, and ethically. National policy documents for data science majors emphasize that engagement with an application domain is an important part of data science education. The University of Illinois' white paper on data science education recommended "X+DS Majors" as an innovative approach to offering broad collaborative opportunities for Illinois students to engage with data science.

The proposed ChemE+DS degree will both prepare our students for the future and enhance their understanding of traditional chemical engineering concepts. Traditional ChBE (like many branches of engineering) mixes first-principles science with practical, powerful, data-driven empiricisms. For example, the correlations that we use for heat, mass, and momentum transfer are rooted in first-principles dimensional analysis, combined with scaling relations and empirical correlations. The data-driven elements of these correlations make them practical and applicable for extremely complex situations, while their starting point (balance equations that identify dimensionless combinations of inputs) makes them transferrable across a range of materials and conditions.

In these past applications of data science, data sets were small and the governing equations were available (if not solvable) to identify all of the relevant variables. Accordingly, engineers made progress with simple statistical analysis tools. Now, large multidimensional data sets require more sophisticated techniques. It is critical that we train chemical engineers on state-of-the-art data science tools and data curation practices to meet the challenges of this new era. It is equally critical that chemical engineers learn about the potentially catastrophic pitfalls of complete reliance on past data in decisions about the future.

Modern data science presents a tremendous opportunity to chemical and biomolecular

Modern data science presents a tremendous opportunity to chemical and biomolecular engineering, but the full power of data science (as seen in our traditional ChBE correlations) will come from a judicious combination of data science and chemical engineering foundations. For this reason, students with a balanced education in both chemical engineering and data science will be uniquely poised to harness the data science revolution for applications in the chemical engineering and the chemical sciences.

Students who graduate from this program will enter the workforce with the technical skills to construct models, to analyze, interpret, and visualize data, and to make data-driven decisions in light of technology, economic, and safety/ethics considerations. These skills will give our ChemE+DS graduates a unique edge in the chemical industry.

We propose a degree plan that combines a strong foundation in chemical engineering with training in data science principles, techniques, and practices. The program includes a traditional core sequence in chemical engineering classes with additional data science coursework requirements (comparable to a minor) and a data science practicum. The proposed degree is comprised of three different components:

1. The data science core coursework (44 hours)
a. This coursework is comprised of:
i. One (1) course from Statistics (STAT 207)
ii. Two (2) courses from Computer Science (CS 277 and CS 101)
iii. Two (2) courses from the iSchool (IS 467 and IS 477)
iv. Five (5) courses from Mathematics
v. ChBE 411
vi. ChBE 412
vii. CS 307 or ChBE 413
2. The coursework in the area of specialization (65 hours)
3. Discovery experiences (ChBE 415, 3 hours)

The proposed curriculum deviates from the standard X+DS core in two key ways. We have omitted STAT 107 and we replaced STAT 400 with a domain-specific calculus-based probability and statistics course (ChBE 411). The reasons for these modifications are explained below:

STAT 107 provides introductions to statistics, data science, and Python programming. We appreciate the critical importance of all three topics, but ChemE+DS students will learn Python, statistics, and data science in other early courses. For programming in Python:

1) CS 101 is a Python based programming course. All engineering majors (including ChBE and ChemE+DS) have to take CS 101, and they typically take this course in the Freshman year.

2) ChBE 412 (Computational Methods in Chemical Engineering) also focuses on Python

programming, with challenging problem sets involving root finding, optimization, numerical integration, differential equation solvers, etc. in the context of chemical engineering problems.

3) Several other courses in the proposed curriculum also reinforce the students' Python programming skills: ChBE 413, Math 257, and CS 307.
ChemE+DS students will also obtain a rigorous training in statistics. They will first encounter statistics as sophomores in STAT 207. Then as juniors, the students will take ChBE 411 (Probability and Statistics for Chemical Engineering) in lieu of STAT 400. ChBE 411 is a calculus-based probability and statistics course. It encompasses nearly all topics from Stat 400 and Stat 107. However, the examples, homework, and exams in ChBE411 are built around chemical engineering applications. These include parameter estimation from reaction rate data, Poisson statistics problems related to catalyst preparation, survival probability data in nucleation assays, polymer conformations and sequence statistics, regression applied in the context of chemical equilibrium and Van't Hoff analyses, categorical data in characterization of chemically functionalized surfaces, non-parametric tests that arise in particle size distribution data, propagation of uncertainties through relations between fluid flow and transport phenomena, and confounding effects in mechanistic studies of catalysis and biochemical processes. The domain-specific training gives our students an opportunity to reinforce their chemical engineering foundations and simultaneously learn probability and statistics in the context of realistic chemical engineering applications.

In reviewing the Stat 400 and Stat 107 courses, we identified two key additions that will be made to ChBE 411:

• The terminology used in past versions of ChBE 411 was not always aligned with proper terminology as introduced in Stat 107 and Stat 400. For example, our students learn experimental designs and hypothesis testing procedures for data that is grouped by strata, but they do not learn that this is called "stratification". To avoid creation of unnecessary language barriers for our students, we will improve the alignment of ChBE 411 with established data science terminology.

• Previous versions of ChBE 411 did not include an introduction to data clustering algorithms, a key part of many data science applications and a topic that students do see in STAT 107. We added a lecture and homework assignment on clustering algorithms to ChBE 411 in Fall 2023.

Stat 107 includes a machine learning introduction lecture. ChBE 411 does not include an introduction to machine learning (but it does include two weeks of lectures on linear regression and analysis of variance tools). ChBE 411 will not go deeper into machine learning because the students will get in depth lessons on these topics in the Stat 207, ChBE 413, and CS 307 courses.

CHBE 300-400 Level Upper Division Coursework:

2 hrs CHEM 315: Instrumental Chem Systems Lab

2 hrs CHEM 420: Instrumental Characterization
4 hrs CHEM 442: Physical Chemistry I
4 hrs CHBE 321: Thermodynamics
3 hrs CHBE 411: Probability and Statistics
4 hrs CHBE 421: Momentum and Heat Transfer
4 hrs CHBE 422: Mass Transfer Operations
3 hrs CHBE 424: Chemical Reaction Engineering
4 hrs CHBE 430: Unit Operations Laboratory
4 hrs CHBE 431: Process Design
3 hrs CHBE 440: Process Control and Dynamics
3 hrs CHBE 412: Computational Tools in Chemical Engineering
4 hrs CHBE 413: Data Science for Chemical Engineering
3 hrs CHBE 415: Chemical Engineering Data Science Experience
3 hrs IS 467: Ethics and Policy for Data Science
3 hrs IS 477: Data Management, Curation and Reproducibility

Total Upper-Division Course Hours: 53

Instructional Resources

Will there be any reduction in other course offerings, programs or concentrations by your department as a result of this new program/proposed change?

No

Does this new program/proposed change result in the replacement of another program?

No

Does the program include other courses/subjects outside of the sponsoring department impacted by the creation/revision of this program?

Yes

Courses outside of the sponsoring department/interdisciplinary departments

MATH 221 - Calculus I
MATH 231 - Calculus II
MATH 241 - Calculus III
MATH 257 - Linear Algebra w Computat Appl
MATH 285 - Intro Differential Equations
STAT 207 - Data Science Exploration
CS 307 - Model & Learning in Data Sci
CS 101 - Intro Computing: Engrg & Sci

CS 277 - Algo & Data Stru for Data Sci
IS 467 - Ethics & Policy for Data Scien
IS 477 - Data Mgmt, Curation, & Reprodu
ENG 100 - Engineering Orientation
CHEM 202 - Accelerated Chemistry I
CHEM 203 - Accelerated Chemistry Lab I
CHEM 204 - Accelerated Chemistry II
CHEM 205 - Accelerated Chemistry Lab II
CHEM 236 - Fundamental Organic Chem I
CHEM 237 - Structure and Synthesis
CHEM 442 - Physical Chemistry I
CHEM 420 - Instrumental Characterization
CHEM 315 - Instrumental Chem Systems Lab
PHYS 211 - University Physics: Mechanics
PHYS 212 - University Physics: Elec & Mag
PHYS 214 - Univ Physics: Quantum Physics
CHEM 102 - General Chemistry I
CHEM 103 - General Chemistry Lab I
CHEM 104 - General Chemistry II
CHEM 105 - General Chemistry Lab II
CHEM 222 - Quantitative Analysis Lecture
CHEM 223 - Quantitative Analysis Lab
MATH 441 - Differential Equations
MATH 220 - Calculus

Please attach any letters of support/acknowledgements for any Instructional Resources consider faculty, students, and/or other impacted units as appropriate.	CHEM course approval.pdf STAT course approval.pdf PHYS course approval.pdf CS course approval.pdf IS course approval.pdf MATH course approval.pdf CHEM course approval 2.pdf ENG course approval.pdf MATH course approval 2.pdf

Program Regulation and Assessment

Plan to Assess and Improve Student Learning

Illinois Administrative Code: 1050.30(b)(1)(D) Provision is made for guidance and counseling of students, evaluations of student performance, continuous monitoring of progress of students toward their degree objectives and appropriate academic record keeping.

List the program's student learning outcomes. Each outcome should identify what students are expected to know and/or be able to do upon completing this program.

Student learning outcomes are based on learning outcomes in line with the Accreditation Board of Engineering (ABET) accreditation process.

Upon completing the program, Chemical Engineering + Data Science students are expected to:

1. Identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

2. Apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

3. Communicate effectively with a range of audiences.

4. Recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

5. Function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

6. Develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

7. Acquire and apply new knowledge as needed, using appropriate learning strategies.

Describe how, when, and where these learning outcomes will be assessed.

Describe here:

Course and Student Outcomes are directly and quantitatively measured in undergraduate core chemical engineering courses each semester. Adjustments and changes to lectures, problem sets, course projects and course emphasis are based on student performance on specific outcomes. The assessment process was applied to the core courses and quantitative and qualitative assessment of student performance, based on specific outcomes, have significantly shaped course improvement and instruction.

At the individual course level, course outcomes are developed by the faculty teaching that course with input from the entire faculty and are described within the individual course syllabi. Each of the course outcomes are matched with relevant student outcomes. Our approach for evaluating student achievement of outcomes involves instructors completing spreadsheets each semester for core courses. In their entirety, the documentation contained within the outcomes assessment spreadsheets directly and quantitatively demonstrates the achievement of student outcomes and tracks course improvement. Our spreadsheet-based process for documenting and measuring the achievement of our outcomes involves several steps:

1. Each instructor or teaching team develops and documents their course outcomes, with input from the faculty.

2. Each instructor designs assessment tools (exams, quizzes, projects, homework assignments, etc.) for each course outcome. These course outcomes are then mapped to student outcomes.

3. Each instructor determines the acceptable level of achievement for each outcome for which students as a whole will be assessed. These attainment levels typically range from 60% to 75% depending upon the type and difficulty of the assessment tool and course material.

4. Each instructor, with the help of a TA, compiles overall student achievement levels for each assessment tool and compares this average to the predetermined minimum achievement level.

5. If any outcome is not achieved, instructors suggest changes or possible reasons for the achievement level below the minimum acceptable level. These course improvements can also be prompted by lower than expected student performance on specific assessment instruments, instructor observations of the course, or best practices in engineering education.

6. In subsequent semesters, the instructors or teaching team close the loop and implement their suggested changes. Individual instructors adjust lectures, problem sets and course deliverables in response to course assessments. Once a change has been implemented, it is evaluated for efficacy. If an outcome is still not being achieved, further modifications are considered. These suggestions for modification can be

further modifications are considered. These suggestions for modification can be instructor-derived, or solicited from other faculty, from a faculty, subcommittee, annual Curriculum Assessment and Review meeting, or from one of the various teaching support resources available to faculty. This process of iterative continuous improvement is performed each time the course is offered.

7. Faculty members submit spreadsheets documenting items 1 through 6 as well as graded samples of all assessment tools which directly measure the achievement of one or more course outcomes tied to one or more student outcomes. This documentation is reviewed for completeness and archived by the Assessment Committee.

Extensive quantitative assessment of student outcomes is reviewed every six years.

Additional qualitative assessment are performed based on instructor observation, which prompt additional course improvements. Individual course spreadsheets, along with course improvement suggestions, samples of graded student work, and annual curriculum meeting minutes are collected and archived by the Assessment Committee every semester and can be made available if desired.

Graduating Student Survey

Senior students are surveyed starting 1-2 months before graduation to collect feedback on outcomes achievement and overall perception of the program. The graduating senior survey is kept open and available for completion for 1-2 months after graduation. This survey is conducted twice a year to allow every student an opportunity to provide feedback, as some students graduate in December. One important aspect of this survey is collecting feedback on the students' own perceived level of achievement of the student outcomes. Though these data are self-reflective, it is an important aspect of assessment since it helps us gauge the students' perceived level of preparedness, achievement and confidence at the time of graduation.

Students are asked to rate on a 1-5 scale their perceived level of achievement of the student outcomes.

For all surveys, any qualitative suggestions are documented and grouped based on topic. The quantitative and qualitative results of the Graduating Senior Survey are compiled, documented, and presented to the faculty once a year. Faculty discussion and resulting action items are documented in the Faculty Curriculum meeting minutes. Often action items are delegated to a sub group of faculty, such as the Undergraduate Curriculum Committee, for further analysis and suggested action if warranted.

Identify faculty expectations for students' achievement of each of the stated student learning outcomes. What score, rating, or level of expertise will signify that students have met each outcome? Provide rating rubrics as necessary.

In addition to what is explained above, we use indirect assessments and informal data sources. To augment Alumni and Employer Surveys which often have very low response rates, the department head and other faculty meet with alumni and

response rates, the department head and other faculty meet with alumni and recruiters/employers, as many are alumni, when they visit campus. Representatives from industry visit faculty and the department head on a regular basis. Every year many recruiters visit campus and several of them meet with faculty and the Head formally or informally. These visits provide the department with an opportunity to collect feedback from alumni. This may include suggestions for improvement of the program and the effectiveness of our placement office in helping recruiters. We also host alumni as guest speakers for courses (3 to 6 every spring for the Introduction to Chemical Engineering Profession course and some for Unit Operations and Design) and as judges (e.g., 2 to 4 for our undergraduate research symposium, 2 to 3 for our design across the curriculum competition). These visitors typically meet with the Head, a number of faculty and student organizers. As a part of our alumni stewardship program, we invite a group of alumni back to campus for a formal or informal seminar. Faculty meet with the alumnus guest one-on-one and also schedule 4 to 10 undergraduates to meet with the visitor.

Explain the process that will be implemented to ensure that assessment results are used to improve student learning.

Annually CHBE faculty hold a Curriculum Assessment and Review meeting. Within this meeting a representative from each core CHBE course reports assessment information, overall perceptions of student strengths, and areas in need of improvement. This meeting is an opportunity to discuss the curriculum as a whole and the propagation of student skills throughout the program. Facilitating smooth transitions from a prerequisite class to a higher level course are discussed and improvements to strengthen the prerequisite course or its structure are evaluated. Specifically, evaluations of overall student strengths and areas in need of improvement are conducted by the faculty teaching the capstone courses, design (CHBE 451) and unit operations (CHBE 430) who continuously evaluate and improve the curriculum through a holistic approach. If the results of this annual Curriculum Assessment and Review meeting suggest the need for significant changes in course structure or coverage, these concerns are referred to the Undergraduate Curriculum Committee for consideration.

Program Description and Requirements

Attach Documents

Is the career/profession for graduates of this program regulated by the State of Illinois?

No

Program of Study

Baccalaureate degree requires at least 120 semester credit hours or 180 quarter credit hours and at least 40 semester credit hours (60 quarter credit hours) in upper division courses" (source: https://www.ibhe.org/assets/files /PublicAdminRules2017.pdf). For proposals for new bachelor's degrees, if this minimum is not explicitly met by specifically-required 300- and/or 400-level courses, please provide information on how the upper-division hours requirement will be satisfied.

Attach Program of Study-related information such as sample sequences (for undergraduate programs) or college-level forms.	ChemE+DS_sample_sequence -LAS Formatted-Final - 11-27-2023.pdf

Catalog Page Text - Overview Tab

Description of program for the catalog page. This is not official content, it is used to help build the new catalog page for the program. Can be edited in the catalog by the college or department.

This major is sponsored jointly by the Departments of Statistics, Computer Science, Mathematics, and Chemical and Biomolecular Engineering, and the iSchool. The Chemical Engineering+Data Science major is designed for students wanting a strong foundation in Data Science with a deep B.S. level specialization in Chemical and Biomolecular Engineering. The major prepares students for professional or graduate work in Chemical and Biomolecular Engineering with additional mastery of statistics, data analysis, data modeling, machine learning, and other data science topics.

Statement for Programs of Study Catalog

Graduation Requirements

Minimum hours required for graduation: 132 hours.

A grade point average of 2.5 or higher in all courses required for the major earned on the UIUC campus is required in order to be accepted by the department as juniors and seniors.

University Requirements

Minimum of 40 hours of upper-division coursework, generally at the 300- or 400-level. These hours can be drawn from all elements of the degree. Students should consult their academic advisor for additional guidance in fulfilling this requirement.

The University and residency requirements can be found in the Student Code (§ 3-801) and in the Academic Catalog.

General Education Requirements

Follows the campus General Education (Gen Ed) requirements. Some Gen Ed requirements may be met by courses required and/or electives in the program.

Course List		
Code	Title	Hours
Composition I		4-6
Advanced Composition		3
fulfilled by CHBE 431		
Humanities & the Arts (6 hours)		6
Natural Sciences & Technology (6 hours)		6
fulfilled by CHEM 202 & CHEM 204 or CHEM 102 & CHEM 104; PHYS 211, PHYS 212		
Social & Behavioral Sciences (6 hours)		6
Cultural Studies: Non-Western Cultures (1 course)		3
Cultural Studies: US Minority Cultures (1 course)		3
Cultural Studies: Western/Comparative Cultures (1 course)		3
Quantitative Reasoning (2 courses, at least one course must be Quantitative Reasoning I)		6-10
fulfilled by CS 101, MATH 221 or MATH 220, MATH 231, MATH 241, PHYS 211, PHYS 212, STAT 207		
Language Requirement (Completion of the third semester or equivalent of a language other than English is required)		0-15

Data Science Core

Mathematical Foundations

Course List

Code	Title	Hours
MATH 221	Calculus I	4
or MATH 220	Calculus	
MATH 231	Calculus II	3
MATH 241	Calculus III	4
MATH 257	Linear Algebra with Computational Applications	3
MATH 285	Intro Differential Equations	3
or MATH 441	Differential Equations	
Total Hours		17

Data Science Fundamentals

Course List

Code	Title	Hours
CHBE 411	Probability and Statistics for ChBE	3
STAT 207	Data Science Exploration	4
CS 307	Modeling and Learning in Data Science	4
or CHBE 413	Data Science for Chemistry and Engineering	
IS 477	Data Management, Curation & Reproducibility	3
Total Hours		14

Computational Fundamentals

Course List

Code	Title	Hours
CS 101	Intro Computing: Engrg & Sci	3
CS 277	Algorithms and Data Structures for Data Science	4
CHBE 412	Computational Tools in Chemical Engineering	3
Total Hours		10

Social Impact in Data Science

Course List

Code	Title	Hours
IS 467	Ethics and Policy for Data Science	3
Total Hours		3

Coursework in Area of Specialization

Chemical Engineering

Course List

Code	Title	Hours
ENG 100	Grainger Engineering Orientation Seminar	1
CHBE 121	CHBE Profession	1
For students entering the curriculum after the freshman year, 1 additional hour of credit may be substituted in consultation with an academic advisor.		
CHBE 221	Principles of CHE	3
CHBE 321	Thermodynamics	4
CHBE 421	Momentum and Heat Transfer	4
CHBE 422	Mass Transfer Operations	4
CHBE 424	Chemical Reaction Engineering	3
CHBE 430	Unit Operations Laboratory	4

Code	Title	Hours
CHBE 431	Process Design	4
CHBE 440	Process Control and Dynamics	3
Total Hours		31

Chemistry Fundamentals

Course List

Code	Title	Hours
Select one group of courses (Accelerated or General Chemistry)		10-12
CHEM 202	Accelerated Chemistry I	
& CHEM 203	and Accelerated Chemistry Lab I	
& CHEM 204	and Accelerated Chemistry II	
& CHEM 205	and Accelerated Chemistry Lab II	
OR		
CHEM 102	General Chemistry I	
& CHEM 103	and General Chemistry Lab I	
& CHEM 104	and General Chemistry II	
& CHEM 105	and General Chemistry Lab II	
& CHEM 222	and Quantitative Analysis Lecture	
& CHEM 223	and Quantitative Analysis Lab	
CHEM 236	Fundamental Organic Chem I	4
CHEM 237	Structure and Synthesis	2
CHEM 315	Instrumental Chem Systems Lab	2
Students must register in one of the Chemical Engineering-specific CHEM 315 lab sections.		
CHEM 420	Instrumental Characterization	2
CHEM 442	Physical Chemistry I	4
Total Hours		24-26

Physics Fundamentals

Course List

Code	Title	Hours
PHYS 211	University Physics: Mechanics	4
PHYS 212	University Physics: Elec & Mag	4
PHYS 214	Univ Physics: Quantum Physics	2
Total Hours		10

Data Science Experience

Course List

Code	Title	Hours
CHBE 415	Chemical Engineering Data Science Experience	3
Total Hours		3

Corresponding Degree	BS Bachelor of Science

Program Features

Academic Level	Undergraduate

Does this major have transcripted concentrations?	No

What is the typical time to completion of this program?

4 years

What are the minimum Total Credit Hours required for this program?

132 hrs

CIP Code	307099 - Data Science, Other.

Is This a Teacher Certification Program?

No

Will specialized accreditation be sought for this program?

Yes

Describe the plans for seeking specialized accreditation:

We will seek ABET accreditation for the ChemE+DS degree program. Note that ABET accreditation does not require assessments for every course. We will seek accreditation of ChemE+DS mainly based on assessments of the Chemical Engineering components. The core components of the Chemical Engineering degree remain complete in the ChemE+DS proposal and these are already being assessed. The only potential challenge in accreditation will be to gain approval for some +DS core requirements that are “engineering design” electives. We will attempt to justify this designation for CS 307, CS 277, and IS 467. We only need to successfully gain approval for engineering design elective status in one of these courses to meet accreditation requirements. We do not anticipate a need for any assistance from Computer Science, Statistics, Math, or Information Sciences in this effort.

Delivery Method

This program is available:

On Campus - Students are required to be on campus, they may take some online courses.

Admission Requirements

Desired Effective Admissions Term	Spring 2025

Provide a brief narrative description of the admission requirements for this program. Where relevant, include information about licensure requirements, student background checks, GRE and TOEFL scores, and admission requirements for transfer students.

Applicants will be admitted in the fall and spring semesters. Requirements for Incoming Freshmen follow the general admission requirements of the University and current ChBE admission requirements. English proficiency is a must and this can be assessed by taking the TOEFL, IELTS, or Duolingo English Test. Calculus is preferred for first year admitted students (if offered in their high school). Students must also demonstrate understanding of and interest in Chemical Engineering.

For inter-college transfer students (ICT) there are several specific requirements. Students must hold a GPA of 3.1 or greater for at least 2 semesters of work. Students must have a grade of C or better in two of the following ChBE courses: ChBE 221, 321, or 421. The department will also review other ChBE courses the student has taken to determine the ability to succeed in chemical engineering. Lastly, students must develop a graduation plan to be approved by the head advisor or a faculty /staff member designated by the department head. The graduation plan must not include multiple difficult classes within the same semester, such as ChBE 430, 431, 440 and CHEM 315.

For transfers from another university, students will need to possess a grade point average of 3.2 or higher. Preference is given to those that can complete a degree requirement within a total of ten semesters (not counting summer sessions). Availability of transfers is also based on space availability. If transferring with more than 80 credit hours of coursework, an additional review is required.

Number of Students in Program (estimate)

Year One Estimate	10	5th Year Estimate (or when fully implemented)
100-120		

Estimated Annual Number of Degrees Awarded

Year One Estimate	5-10	5th Year Estimate (or when fully implemented)
25-30		

What is the matriculation term for this program?

Fall

Budget

Will the program or revision require staffing (faculty, advisors, etc.) beyond what is currently available?

No

Additional Budget Information

Attach File(s)

Financial Resources

How does the unit intend to financially support this proposal?

This is a revision of an existing degree program to partner with a data science component, and the anticipated effects are mainly shift in course enrollments that are already offered within the ChBE, CS, STAT, MATH, and IE units. New courses largely shift enrollments between participating units who are well-established already. Because of this and the lack of need for any additional faculty, staff, or additional resources, we do not expect any of these shifts or changes to cause a need for new costs with the introduction of this degree program.

Will the unit need to seek campus or other external resources?

No

Attach letters of support

What tuition rate do you expect to charge for this program? e.g, Undergraduate Base Tuition, or Engineering Differential, or Social Work Online (no dollar amounts necessary)

Engineering Differential

IBHE

Degree Program Title and Overview

What is the specific title of the proposed degree program as it would be listed in the IBHE Program Inventory? The name should be what typically is used for similar programs nationally. Provide a short description of the program, including highlights of the program objectives, and the careers, occupations, or further educational opportunities for which the program will prepare graduates.

Chemical Engineering + Data Science

We propose a degree plan that combines a strong foundation in chemical engineering with training in data science principles, techniques, and practices. The program includes a traditional core sequence in chemical engineering classes with additional data science coursework requirements (comparable to a minor) and a data science practicum.

Graduates would find careers in a broad range of industries including chemical and petroleum engineering, energy, advanced materials, biotechnology, semiconductor manufacturing.

The proposed degree is comprised of three different components:

1. The data science core coursework (44 hours)
a. This coursework is comprised of:
i. One (1) course from Statistics (STAT 207)
ii. Two (2) courses from Computer Science (CS 277 and CS 101)
iii. Two (2) courses from the iSchool (IS 467 and IS 477)
iv. Five (5) courses from Mathematics
v. ChBE 411
vi. ChBE 412
vii. CS 307 or ChBE 413
2. The coursework in the Chemical Engineering area of specialization (65 hours)
3. Discovery experiences (ChBE 415, 3 hours)

Illinois Administrative Code: 1050.30(a)(1): A) The objectives of the unit of instruction, research or public service are consistent with the mission of the college or university; B) The objectives of the unit of instruction, research or public service are consistent with what the unit title implies.

Institutional Context

University of Illinois at Urbana-Champaign

Describe the historical and university context of the program's development. Include a short summary of any existing program(s) upon which this program will be built.

Explain the nature and degree of overlap with existing programs and, if such overlap exists, document consultation with the impacted program's home department(s).

The University of Illinois at Urbana – Champaign became the first university to host a digital computer in 1952, and it has remained a leading institution in Computer Science since that time. Illinois and its alumni have contributed include core hardware, logic, and math operations that remain in use today, as well as ubiquitous parts of our digital experience like PayPal, YouTube, and the digital library. Illinois continues to host the national center for supercomputing applications (NCSA). Illinois' tradition of excellence in Computer Science draws thousands of top STEM applicants each year.

UIUC is also home to one of the nation's first Chemical Engineering departments. Since its founding in 1901, the department has consistently been ranked among the best in the nation. Our alumni include CEOs and CTOs of multinational corporations like General Electric, Dow, PPG, Shell, and International Paper. Our alumni also include numerous past and present NAE caliber academics. The undergraduate program, currently ranked 8th in the nation, draws excellent undergraduate applicants from Illinois.

Computation and data sciences are already important topics within the chemical engineering curriculum. Our students take all of the required math courses for an X+DS degree. They are required to complete one of two rigorous probability and statistics courses, with "Computational Methods" one of our most popular undergraduate electives. Clearly math, statistics, and computing are already viewed as essential skills within ChBE. Our faculty and students are unanimously excited about the development of this new program.

Briefly describe how this program will support the University's mission, focus and/or current priorities. Demonstrate the program's consistency with and centrality to that mission.

The Public Agenda for Illinois Higher Education aims to direct policies and resources based on career needs of Illinois residents and to address current and future economic needs of Illinois. Data scientists transform raw data into meaningful, actionable conclusions – a task that is critical for all modern industries. According to the Bureau of Labor Statistics, data science and data analytics is a growing market nationwide. Illinois in particular has one of the nation's highest location quotients, i.e. data analytics positions are a higher share of the job market in Illinois than in most other parts of the country. The jobs pay extremely well, with a nationwide average of $108K/yr.

We emphasize that the salary figure above is for the broad discipline of Data Science. The mean wage for a Chemical Engineer is $122K/yr. We anticipate that the unique combination of Chemical Engineering + Data Science will draw higher salaries than chemical engineering alone. Data science has transformed Chemical Engineering research in the past decade. The research efforts have been enthusiastically embraced by both industry and academia, suggesting that Data Science will soon be integrated in standard chemical engineering jobs and curriculum. The proposed ChemE+DS program will prepare Illinois' next generation of chemical engineers for this coming transformation.

Note that Chemical Engineers are essential to petroleum refining, which is not a major industry in Illinois, but also to the chemicals industry, to agriculture and fertilizer production, and to the manufacturing of everything from food to paints and coatings. All the latter are important industries in Illinois, and all these industries would benefit from a local supply of Chemical Engineers with unique Data Science training. If we can act quickly, Illinois has the opportunity to be among the first ChemE+DS programs, creating a unique pool of STEM expertise in Illinois.

Discuss projected future employment and/or additional educational opportunities for graduates of this program. Compare estimated demand with the estimated supply of graduates from this program and existing similar programs in the state. Where appropriate, provide documentation by citing data from such sources as employer surveys, current labor market analyses, and future workforce projections. (Whenever possible, use state and national labor data, such as that from the Illinois Department of Employment Security at http://lmi.ides.state.il.us/ and/or the U.S. Bureau for Labor Statistics at http://www.bls.gov/).

The chemical engineering job market is highly competitive. In recent years the number of new job openings has been comparable to the number of chemical engineering graduates, and the market (26,800 total jobs according to the Bureau of Labor) is growing slowly. In contrast, the total number of data science jobs (106,000 total jobs according to the Bureau of Labor) is larger and growing faster. ChemE+DS graduates will not qualify for most of the massive data science job openings, but (to our knowledge) no other university has a chemical engineering + data science degree program at the undergraduate level. Thus even a few hundred data science jobs that require chemical engineering domain expertise would give our graduates an enormous advantage.

It is increasingly recognized that team members with domain expertise are critical for data science project success. Some understanding of the foundations is invaluable for building useful models and software, because even black-box models require specification of the relevant input and output variables. Belyadi and Haghighat write “If a data scientist has no practical experience in an industry, it is extremely difficult to understand relationship between variables.” [Machine Learning Guide for Oil and Gas with Python, Elsevier (2021)]. For these niche jobs, there is reason to believe our ChemE+DS graduates will be even more desirable than top candidates from Computer Science or Statistics programs.

What resources will be provided to assist students with job placement?

Students will have access to the School of Chemical Sciences Career Service Department as well as the Grainger College of Engineering's Career Service Department. The school of Chemical Sciences has 3 academic advisors and 2 staff in their Career Services Department. Grainger College of Engineering has 14 staff in their Undergraduate Program Office, 6 staff in the Computer Sciences Office, and 20 other staff in various engineering department offices.

The School of Chemical sciences helps to facilitate and support Connections between employers and job seekers. They help with job searches for full time employment as well as summer/semester internships and co-ops. They use the platform Handshake@Illinois to notify students of job and internship opportunities. They also have on-campus employment interviews and many programs to help students prepare for those interviews. Those programs include mock interviews, resume and cover letter reviews, and workshops to aid students during each step of the recruitment process. They also host a fall and spring engineering career services career fair at the Illini Union.

Chemical Engineering Students also have access to the Grainger College of Engineering Career Services Department and receive job opportunities, employer events and career event information through Handshake@illinois. Grainger also has opportunities for professional development presentations and resume reviews sessions held by Engineering Ambassadors. They have mentoring through an extensive alumni network via the Grainger Engineering Link.

If letters of support are available attach them here:

Comparable Programs in Illinois

Illinois Administrative Code: 1050.30(a)(6): B) The unit of instruction, research or public service meets a need that is not currently met by existing institutions and units of instruction, research or public service. For additional information about similar programs, check the Degree Program Inventory on the IBHE website (https://www.ibhe.org/ProgInv_Prog.aspx) and review the Notice of Intent website for programs being planned (https://legacy2.ibhe.org/ODA/tracking/NOI/NOISearch.asp).

Identify similar programs and sponsoring institutions in the state, at both public and private colleges and universities. Compare the proposed program with these programs, and discuss its potential impact upon them. Provide complete responses, do not reference website links.

Currently, there are no other programs/majors, at the undergraduate level, like the one being proposed by ChBE, in Illinois, the U.S., or internationally.

Comparable Programs in Illinois Attach Documents

A Thriving Illinois: Higher Education Paths to Equity, Sustainability, and Growth

IBHE is charged to develop a strategic plan to address the present and future aims and needs and requirements of higher education in Illinois (110 ILCS 205/6) (from Ch. 144, par. 186) Sec. 6). Illinois Administrative Code:

1050.30(a)(6): A) The unit of instruction, research or public service is educationally and economically justified based on the educational priorities and needs of the citizens of Illinois Respond to the following questions about how the proposed program will support the three goals of A Thriving Illinois: Higher Education Paths to Equity, Sustainability, and Growth Strategic Plan.

Equity

Describe institutional-level plans to close equity gaps in access, progression, completion, and attainment and the implications for the proposed program. More specifically, provide institutional-level plans for attracting, recruiting, retaining, and completing a diverse group of students including working adults, students of color, transfer and low-income students and implications for the proposed program. Explain how progress will be monitored.

8A. The University of Illinois System recognizes the significance of bridging equity gaps among its citizens in order to fulfill its mission. The University of Illinois actively works to address equity disparities among individuals throughout Illinois, both in urban and rural areas.

A Thriving Illinois, Equity Strategy #2: These are strategies set forth by the IBHE to attain equitable access to higher education. See ibhestrategicplan.ibhe.org/SP_Equity_Strategies.html. Pursuant to these goals, the UI System's Access 2030 Strategic Plan aims to increase the number of graduates from underrepresented groups by 50 percent by the end of the decade. This initiative encompasses students from disadvantaged backgrounds, including those from ethnic and racial minorities, rural areas, and urban communities. It reinforces the University of Illinois' commitment to serving the public good by ensuring that no communities are left behind while striving to improve life in the state. Additionally, it builds upon existing efforts to foster opportunities for individuals of all backgrounds in Illinois.

Scholarships: The university also supports underrepresented groups and underrepresented counties through the President's Award Program (PAP), totalling over $15 million / yr. PAP scholarships are given for $5,000/yr up to 4 years, and the PAP Honors program scholarships are $10,000/yr for 4 yrs. Both provide assistance to students from underrepresented groups across the UI System.

Student recruitment and retention: The University of Illinois runs the Salute to Academic Achievement (SAA). SAA invites students from underrepresented groups and counties to the college-fair event according to their GPA, test scores, and high school nominations. Participants meet with college, admissions, financial aid, and housing representatives from universities in the UI System. They further receive application fee waivers for UI system universities. In 2021, approximately 4600 students were invited and over 10% attended.

The University of Illinois Urbana-Champaign also has outreach and recruitment programs specifically designed for historically underrepresented minority students, including Discover Illinois and Días de Visita en Español.

The university actively participates in several other student retention initiatives. As part of the American Talent Initiative (ATI) the University of Illinois Urbana-Champaign has set the following goals: 1. increase the six-year graduation rate for Pell students to 81% for the 2017 entering cohort; 2. increase targeted opportunities for incoming students to participate in summer scholar/bridge programming in an attempt to increase the number of Pell students enrolling, improve retention rates, and reduce graduate rate gaps for this population

graduate rate gaps for this population.

As part of the Association of Public and Land Grant Universities Powered by Publics (APLU PxP) both to increase graduation rates and expand access to education for all students. The goals of APLU PxP are to produce several hundred thousand more degrees by 2025; to eliminate the achievement gap for low-income, minority, and first-generation students; and to expand access to higher education for students from all backgrounds. One hundred thirty (130) universities and state systems participate in 16 transformation "clusters."

UIUC leads the Big Ten Academic Alliance (BTAA), which studies trends in retention and barriers faced by students. In addition to student retention, the BTAA tracks course "DFW" (D grades, F grades, and Withdrawals) to understand and address specific bottlenecks (across institutions) in student success. UIUC is using the results to identify courses where additional support is needed for students. For example, BTAA institutions shared information on DF grades in the first semester. The graduation gap between students who had one D/F grade in their first semester vs. those with no DF grades was 19.9%; the gap for those with multiple D/F grades was 47.3%.

The Student Success Initiative (SSI) at UIUC aims to enhance student success through improved access, equity, and overall experience. Goals include increasing access, reducing costs, and providing financial aid. It also strives to close equity gaps by improving retention and graduation rates for underrepresented students. The SSI promotes inclusive campus programs and support services, organizes events like the Student Success Symposium, and implements projects like the Mental Health Working Group and Faculty and Staff Mental Health Ambassador Program. It addresses COVID-related learning loss and streamlines the Learning Management System. In the upcoming year, the SSI will focus on enhancing first-year and transfer student experiences, increasing access for underrepresented students, and providing professional development for faculty to ensure quality outcomes.

The Morrill Engineering Program is to empower African American, Hispanic, and Native American engineering students, support their success as scholars, and enable them to leverage a community of students, staff, and alumni to achieve excellence in engineering. The MEP program hosts a variety of activities throughout the year to enhance the student experience.

Transfer guarantee program: This program guarantees admission to one of the three UI system campuses if a student (i) graduated from an Illinois high school, (ii) attended an Illinois community college, (iii) attained 36 graded credit hours and a minimum 3.0 GPA, and (iv) satisfy the UI system language requirement. The transfer guarantee program provides an affordable path to a four-year degree for economically disadvantaged students, pursuant to Growth Strategy #8 by the IBHE. The University of Illinois Urbana-Champaign coordinates several seamless transfer programs with community colleges. The Parkland Pathway allows students to simultaneously enroll at Parkland College and UIUC while living in UIUC residence halls. UIUC also coordinates advising services with City Colleges of Chicago, Danville Area Community College,

Illinois Central College, and Rock Valley College.

Test optional policies: The university has adopted a test-optional policy, making ACT/SAT scores optional for first-year applicants. The test-optional policy is part of a shift toward more holistic application criteria, motivated by the strong correlation between standardized test scores and socioeconomic background. Merit-based and honors programs also do not require test scores for consideration.

The Academic Redshirt in Science and Engineering (ARISE) program prepares talented students from the state of Illinois to succeed in Engineering at Illinois. Up to 25 students are named ARISE scholars every year, giving them an extra year to get ready for traditional first-year courses. The program includes a customized curriculum, individual faculty mentors, tutoring, and career services.

Common app: Starting in 2022, the University of Illinois became part of the Common App program, which allows students to easily and inexpensively apply to numerous universities. The Common App program also helps guidance counselors at schools with limited resources easily scale their efforts in helping students. ChBE applications jumped approximately 20% in the year that the common app began.

Office of the Vice Chancellor for Diversity, Equity, and Inclusion (OVCDEI): The University of Illinois Urbana-Champaign (UIUC) has a strong focus on diversity, equity, and inclusion. The OVCDEI leads these efforts, impacting students, faculty, and staff. Student-focused programming sets the tone for equity strategies. A campus-wide climate assessment will be launched in the 2022-2023 academic year to gauge students' sense of safety, acceptance, and value. The university collaborates with external organizations, peer institutions, and the Association of American Universities (AAU) to ensure the assessment is comprehensive and benchmarked against peers.

Chancellor's Call to Action to Address Racism and Social Injustice: UIUC is committed to equity through the Call-to-Action program which has funded 22 selected proposals in 17 departments, for approximately $2 million annually.

College, Department, and Program-level plans

The Department of Chemical Engineering recognizes the importance of diversity in gender, ethnicity, sexual orientation, disability status, national origin, religion, and socio-economic status. We understand that diverse talent is a strategic asset that allows for more effective research and teaching. We believe in a scientific culture that aspires to the highest standards of professionalism, promotes psychological safety and encourages respect for others, so everyone can bring their best creative selves to the department.

The Department of Chemical and Biomolecular Engineering (future home of ChemE+DS) aims to create an inclusive and discrimination-free environment for all. A recent National Academies report highlighted challenges related to sexual harassment

Recent National Academies report highlighted challenges related to sexual harassment and faculty accountability within the science and engineering community. To address these issues, the department plans to establish a community-based approach through continuous feedback, advocacy, and proactive policies. Initiatives to improve climate and diversity include setting workplace expectations, conducting faculty workshops on personnel management, establishing a Program Climate Review Committee, and discussion of mental health, anti-racism policies, and sexual harassment training in syllabi and courses. Our students benefit from several services and opportunities within the Chemical Engineering department, the School of Chemical Sciences, the College of Liberal Arts and Sciences, and the College of Engineering. The include the following services, scholarships, and student organizations:

Student organizations that help to create a cohesive community for underrepresented students include the National Organization for Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE), Society for Advancing Chinos/Hispanics & Native Americans in Science (SACNAS), and the Annual Biomedical Research Conference for Minority Students (ABRCMS).

The Claire Boothe Luce (CBL) program aims to support women undergraduates seeking to study or teach science, mathematics, and/or engineering, creating a pathway to graduate studies. Each year, eight women undergraduates are selected to take part in the Illinois Scholars Undergraduate Research program and work closely with a faculty sponsor/graduate student mentor on research projects.

The department also supports students from underrepresented groups and backgrounds through numerous scholarships including:

Corn Family Scholarship: Awarded to chemical engineering students, with a preference for women and/or underrepresented students.

Chester W. Hannum Scholarship: Awarded to able and needy students in the Department of Chemistry or Department of Chemical and Biomolecular Engineering.

Dr. Jerrod A. Henderson Scholarship: Awarded to students based on merit who contribute to the diversity of the student body in the unit.

Kenneth E. Jaconetty Scholarship: Awarded to students who contribute to the diversity of the student body in the unit, established to combat institutional racism and promote inclusivity.

John W. Latchum Jr. Scholarship: Awarded to chemical engineering students with financial need and a strong work ethic.

Marchoe Dill Northern Scholarship: Awarded to underrepresented students in chemical engineering.

Pathways to Success Scholarship: Designed to attract traditionally underrepresented

students in chemical engineering, offered to outstanding incoming freshmen.

Describe program and institution-based high-impact practices and wrap-around student support services ensuring equitable access and success for students enrolled in the proposed program.

8B. The pandemic had a disproportionate impact on students from low-income and minority families, amplifying existing challenges in higher education. To help students regain their pre-pandemic learning trajectory, the IBHE recommends extending learning opportunities, providing proactive advising, and offering wrap-around supports are also essential. High-impact practices, tailored for underrepresented minority students, such as service learning, research opportunities, and internships, contribute to student success and retention. Additional wrap-around support (those provided by an extended team of professionals like family, health workers, teachers, financial advisors, etc.) are also important components.

The University of Illinois Urbana-Champaign takes pride in its leadership on high-impact practices and services for students. These support practices foster ongoing learning renewal and the implementation of evidence-based approaches, aligning with Equity Strategy #1 of A Thriving Illinois. Students have access to resources such as the Counseling Center, Office of the Dean of Students, McKinley Health Center, and Student Assistance Center, which are available in-person or remotely to promote student wellness and retention. The university's Writer's Workshop offers workshops and writing assistants to assist all students with their writing projects. Disability Resources & Educational Services (DRES) has also played a significant role in supporting students with disabilities, contributing to the university's reputation as a national leader in post-secondary education for individuals with disabilities. DRES is responsible for numerous innovations:

- The first architectural accessibility standards that later became the American National Standards Institute Standards;
- The first wheelchair-accessible fixed route bus system;
- The first accessible university residence halls;
- The first university service fraternity and advocacy group for students with disabilities, Delta Sigma Omicron; and
- The first university to receive the Barrier-Free America Award from the Paralyzed Veterans of America (2012).

The Counseling Center, McKinley Health Center, and Student Assistance Center are easily accessible to all students, whether in-person or remotely, to enhance student well-being and retention. Students are encouraged to participate in Writer's Workshop activities, and writing assistants are available to provide support on course projects. These services, in combination with DRES, have helped to establish Urbana-Champaign as the leader in post-secondary education for individuals with disabilities.

The Office of Inclusion and Intercultural Relations (OIIR) offers several programs aimed at supporting diverse student groups, including working adults, students of color, and transfer and low-income students. OIIR is home to UIUC's cultural and resource centers, as well as various impactful programs. Three examples of these programs are the 100 STRONG Program, I-Connect Diversity & Inclusion Workshops, and Housing

the 100 STRONG Program, I-Connect Diversity & Inclusion Workshops, and Housing Division Social Justice and Leadership Education. The Chez Veterans Center, located within the College of Applied Health Sciences, provides support for veterans, including personalized academic and career coaching, mentoring opportunities, and health and wellness services to enhance overall well-being.

The Office of Minority Student Affairs (OMSA) at the University of Illinois Urbana-Champaign is a long-standing and extensive student support program that reflects the university's commitment to its land-grant mission. OMSA has been dedicated to promoting access for all students and offering a wide range of college preparatory and support services to enhance student success since its establishment. OMSA's programs, such as AMPS (Academic Mentoring, Programs, and Services), align with Equity Strategy #8 of A Thriving Illinois by incorporating near-peer mentoring and staff as mentors/coaches.

The Illinois Scholars Program (ISP) serves Illinois residents from historically underserved populations and counties with low college attendance rates. ISP facilitates a smooth transition for entering students by offering educational, personal, social, and cultural opportunities. The program begins with a rigorous four-week summer bridge experience for incoming first-year students, and it continues to provide ongoing support and community throughout the students' undergraduate years. The program outcomes are correlated to student success. Over 100 students have successfully completed the summer bridge experience, resulting in 93.9% retention from freshman to sophomore year. This retention rate surpasses the campus average of 91.5% for underrepresented minority students.

The University of Illinois System has introduced the Access 2030 initiative to increase the number of graduates from underrepresented groups by 50% by the end of the decade. The initiative focuses on ethnic and racial minorities from disadvantaged backgrounds in rural and urban areas. Access 2030 is intended to promote equity and diversity across the U of I System universities. Each university will develop tailored plans, encompassing student readiness, recruitment, retention, and graduation, with support systems like mentoring and bridge programs. The initiative seeks to close equity gaps from K-12 through college, building on the universities' previous efforts that have already increased enrollment of underrepresented students by over 68% in the past decade. Systemwide retention rates for these students are on par or exceed national averages.

College, department, and program-level high-impact and wraparound support services

The School of Chemical Sciences (SCS) offers excellent wrap-around services including academic advisors and career services professionals who specialize in helping Chemical Engineering students. SCS Advising and Career Services plan to provide these services for ChemE+DS if the new major is approved.

SCS Career Services office seeks to provide guidelines, resources, and opportunities to SCS job seekers to help them achieve their career aspirations and to facilitate

connections between employers and those job seekers. They provide guidance for careers in industry, for higher education, and for practical experiences like internships and co-ops. Specific examples of popular services include job search coaching, mock interviews, professional development workshops, and assistance with resumes, CVs, and cover letters.

SCS Advising – Our students benefit from a team of advisors with specific Chemical Engineering expertise. The advisors help students with a number of conventional services, e.g. course selection, navigating of university and department policies, degree planning (e.g. with a roadmap to 4-yr graduation), and monitoring academic progress. The SCS Advisors also help students with wrap-around services like setting personal goals, career positioning, and finding resources like writing centers and counselors. SCS advisors are understanding of students' life situations and experiences, and they work with students whenever possible to accommodate their diverse needs.

C² at the University of Illinois Urbana-Champaign promotes excellence among underrepresented Chemistry and Chemical Engineering majors. C² facilitates partnerships with graduate student mentors and organizes monthly networking and professional development events. The program fosters a scholarly community where diversity and excellence flourish. Additionally, C² offers one-on-one peer mentorship, professional development workshops, networking opportunities, and the chance to apply for Summer Research Scholarships and competitive Travel Awards for research presentations at national conferences.

The Shell Tutoring Program (sponsored by Shell Oil Co.) supports hourly pay for peer tutors. Shell tutors are selected from a competitive pool of applicants to provide our undergraduates with focused assistance in core Chemical Engineering course material. The Shell tutors hold office hours and study sessions where students can learn by working with peers in an informal setting.

ChBE Learning Centers: ChBE offers several Learning Centers for undergraduate student use. The facilities feature computers, printers, study areas, and whiteboards for group study.

The Research Park, a University facility in Champaign, IL, collaborates with various industry-focused initiatives and organizations. Many internship opportunities at the Research Park promote diversity, equity, and inclusion in Science, Technology, Engineering, and Mathematics. Examples include Synchrony's sponsorship of FOCUS Scholars and the Motorola Solutions' partnership with the National Society of Black Engineers. Moreover, the Research Park works closely with affinity and community groups on campus, maintaining partnerships with units like La Casa Cultural Latina, the Bruce Nesbitt African American Cultural Center, and The Career Center, as well as student groups such as the Society of Women Engineers, and Alpha Omega Epsilon (professional women's leadership sorority). These opportunities provide unique experiences for Illinois' diverse students in the Research Park. Additionally, the Illinois Reboot tech training program offers a free data science course to underrepresented

Reboot tech training program offers a free data science course to underrepresented Central Illinois professionals, with 61 percent of its 150 trainees since 2020 coming from underrepresented populations. Reboot also provides career coaching and access to Research Park data science professionals.

The Campus-Community Compact (Compact) is a major initiative of UIUC's Call to Action to Address Racism and Social Injustice. It is a co-equal partnership between UIUC and the Champaign-Urbana community, aiming to accelerate social justice by addressing structural racism, bias, and social injustice in six grand challenge areas: inclusive education, accessible technology, economic development, health, wellness, and resilience, workforce development, and community relations. Additionally, the Compact includes crosscut areas like accessible campus/transportation, accessible information, community safety, and language (e.g., multilingualism, communications, and messaging). The initiative seeks to make significant progress over the next 5-10

Explain institutional strategies being implemented to increase and retain faculty, staff, and administrators of color and the implications for the proposed program. Explain how progress will be monitored.

8C. Pursuant to IBHE Equity Strategy #3, the UI System supports efforts to cultivate and retain underrepresented minority faculty. In particular, the Distinguished Faculty Recruitment Program has a stated goal of increasing underrepresented minority faculty. Since 2017, the System has committed $20 million to this program, the recruitment of tenured, star, or rising faculty from a range of disciplines who can transform our universities by their exceptional scholarship and teaching.

The Public Voices Fellowship is a year-long program open to tenured faculty to join a cohort of leaders, the majority of whom will be underrepresented (including women) and provide them with extraordinary support, leadership skills, and knowledge to ensure their ideas shape not only their fields, but also the greater public conversations of our age. The Leadership Initiative for Women Faculty brings together women faculty from across the UI System who are leaders and/or potential leaders to identify barriers to and facilitators for advancement of women. Finally, the System will also be providing funding in support of each university’s faculty recruitment plans which will also emphasize the recruitment of underrepresented minority faculty.

The University of Illinois Urbana-Champaign is making strategic investments in faculty recruitment to uphold our academic strengths, address student needs, and seize new opportunities. These investments are particularly important in the competitive market for top talent. The Next 150 strategic plan includes an initiative to expand our faculty in key areas over the next five years. The hiring initiative was hindered by the COVID-19 pandemic, but the university remains committed to its efforts to hire diverse faculty.

Specific hiring decisions are largely left to departments and colleges, but the campus has allocated significant resources to encourage diversity in the hiring process. Two prominent programs in this regard are the Targets of Opportunity Program (TOP) and

the Dual Career Academic Couples (DCAC) program. The TOP program offers ongoing financial support in the form of salary funds to facilitate the recruitment of faculty who enhance campus diversity, with a specific focus on underrepresented groups and women in STEM fields. These hires are typically identified through conventional search processes, but faculty search committees must document their efforts to reach and interview diverse applicants. Additionally, the Office of the Provost, in collaboration with the Office of the Vice Chancellor for Diversity, Equity, and Inclusion, recently introduced a temporary modification to the TOP program to foster the recruitment of more faculty of color. This initiative has made an additional approximate sum of $1 million available to units to support hiring efforts in this specific area. For the DCAC program, the Provost provides recurring matching funds equivalent to one-third of the initial salary if the partner is hired into a tenure track position through the DCAC program. The DCAC program was recently extended to include non-recurring funds for partner hires in non-tenure track positions.

The Provost's Underrepresented Faculty Recruitment Program offers non-recurring research funds to strengthen employment offers. For individuals hired during the 2022-2023 academic year, grants of up to $20,000 per year were available for each of the first three years of employment. The Provost's Office allocates funds to cover supplementary search expenses when candidates from underrepresented groups visit campus.

The Office of the Provost is also investing in faculty development. Starting from recruitment and onboarding, all the way through promotion and retirement, faculty members are provided with tailored programming and resources to address their specific career needs. Additionally, the office extends support for institutional memberships that grant access to external resources for our faculty. Examples include access to the National Center for Faculty Development and Diversity (NCFDD) and the Collins Scholars programs.
Additional programs and resources to enhance retention are made available to executive officers and faculty members at all ranks. These initiatives equip unit executive officers with skills to effectively support and mentor faculty, with a specific emphasis on faculty members of color. Additionally, the Provost's Office organizes leadership development programs aimed at expanding the pool of potential academic leaders. These programs intentionally prioritize campus leadership and administrative roles for faculty members from marginalized and underrepresented groups.

To track the effectiveness of our diversity, equity, and inclusion efforts in faculty recruitment and retention, we gather, oversee, and publish yearly data through the Division of Management Information and Office for Access and Equity.

College, department, and program-level efforts to recruit and retain faculty, staff, and administrators of color

Chemical and Biomolecular Engineering has fully embraced the University emphasis on efforts to hire diverse faculty and staff. Each hiring committee includes a specific diversity advocate. The diversity advocate ensures that all committee members are

aware of best practices and that all members have completed the DiversityEdu program within three years of the search. The Diversity Advocate also helps to shape the position advertisement strategy to reach a diverse pool of qualified applicants. Finally, the diversity Advocate documents the good faith efforts to advertise the position and adhere to best practices throughout the search. Good faith efforts include several required advertising locations: U of I job board, HigherEd Jobs and Affirmative Action Email, Illinois Diversity, Big Ten Academic Alliance Directory, and Diversifying Higher Education Faculty in Illinois Program, and National Professional Journal (in our case, The American Institute for Chemical Engineering (AIChE) Journal). In recent faculty and specialized teaching faculty searches, our finalists (selected for on-site interviews) were mostly women and underrepresented minorities. In our last four

Sustainability

Describe strategies and initiatives the institution plans to implement that makes the proposed program and college more generally affordable for students and their families, including those who have been historically underserved.

8D. The department program for Chemical Engineering + Data Science provides a number of features which complement college and university efforts to improve accessibility and affordability for students and their families including those who have been historically underserved. The program elements have impact both for attracting such students to UIUC and for retaining the students, keeping them on a path for a successful degree experience.

Complementing the University program to improve accessibility for community college students, the degree program is designed to be compatible with students attending community colleges for their first two years of college education. For typical students from community colleges, a 5 semester plan at UIUC will lead to the BS degree. Compared to the standard sequences in the 1st two years at UIUC, 18 out of 20 courses are generally available at community colleges. Furthermore, up to additional 8 courses in General Education which are taken in 3rd and 4th years in the standard sequences may be taken at community colleges.

Students from community colleges and from disadvantaged programs at the secondary school level may find themselves out of sync with standard technical sequences owing to lack of perquisites or inadequate training in Mathematics or Chemistry. To accommodate the needs of these students, the CHBE department (Chemical and Biomolecular Engineering) offers every required core course every semester. This greatly increases the flexibility in designing custom sequences to maximize success for these students.

Students in the existing Chemical Engineering major and in the proposed ChemE+DS program will have excellent opportunities to participate in industrial internships during summer terms beginning after the freshman year. Corporations place a high priority in attracting under represented groups to these internships. The internships provide an improved pathway to future permanent employment as well as an increase in student motivation by giving them better vision of future career opportunities. In addition, internships provide significant income to help students and their families with financing their education. Students can go beyond summer internships to include co-operative terms in alternating semesters throughout their undergraduate years. These co-ops can provide salaries approaching the level of BS graduates and thus provide critical sources for financing a student’s education. Co-op students in many programs and universities find constraints and course scheduling issues in trying to synchronize with campus schedules. Bu contrast, The CHBE department facilitates these opportunities by the aforementioned strategy of offering every required core course every semester. Overall, these features of the ChemE+DS degree (as well as the standard ChemE major) provide a level of support for campus priorities in accessibility, affordability and retention which go above and beyond the existing campus wide programs focused on these issues.

The State of Illinois AIM HIGH Grant program provides $5,000/yr awards to top academically admitted new freshmen.

Incoming Liberal Arts and Sciences (LAS) students at the University of Illinois are automatically considered for scholarships administered by the college. The information from their application for admission is used for scholarship consideration. For need-based scholarships, the information from the Free Application for Federal Student Aid (FAFSA) is used for scholarship selection. Continuing students apply for scholarships through a central application portal, with criteria again considering both merit and need. The availability of one centralized application portal helps to ensure that scholarship funds are utilized. The typical number of scholarships awarded is ca. 130 accouting for approximately $500,000 per year of support. As noted in item 8a, the Chemical and Biomolecular Engineering department and the School of Chemical Sciences, and the College of Engineering each offer additional scholarship opportunities to our students.

The University of Illinois at Urbana-Champaign also helps to mitigate financial barriers to higher education through financial aid. The university offers over $465 million / yr in financial aid to undergraduate students, benefiting 72% of the student body. A significant portion of this funding, amounting to over $145 million, is derived from institutional sources and primarily awarded as need-based grants and scholarships to Illinois residents. The university has two notable financial aid programs. The Illinois Promise program, initiated in 2005, covers tuition, fees, housing, and books/supplies through a combination of federal, state, and institutional grants, along with a $2,500 Federal Work-Study award. It is available to Illinois residents from families with income at or below the federal poverty level. The Illinois Commitment program, launched in 2019, provides grants to cover tuition and fees for Illinois residents with a family income of $67,100 or less. Approximately 30% of Illinois residents attending UIUC receive funding through the Illinois Promise or Illinois Commitment programs. Notably, of the 2020-2021 cohort of Illinois Commitment recipients, 36% identify as Hispanic, 28% as White, 19% as Black/African American, 14% as Asian, and 3% identify as two or more races.

Finally, to alleviate financial constraints that impact retention, the University of Illinois at Urbana-Champaign recently changed the threshold past-due balance that prevents course registration. This had been imposed on any student with a past-due balance of $200 or more. Now the sanction is imposed on students with a past-due balance of $1500 or more, pursuant to Sustainability Goal, Strategy 3 of A Thriving Illinois.

Provide tuition cost analysis for comparable programs and institutions in Illinois.

8E. UIUC Chemical Engineering + Data Science, $22,836 tuition + fees per year

Northwestern University, BS in Data Science, $64,887 tuition per year
Northwestern University, BS in Chemical Engineering, $64,887 tuition per year
University of Chicago, BS in Data Science, $63,801 tuition per year
University of Illinois at Chicago, BS in Chemical Engineering, $18,594 tuition + fees per year

Growth

Provide a supply and demand analysis for the proposed program that, at minimum, does the following: a) Provides evidence of student interest in the proposed program including any strategies to incentivize students to stay in Illinois. b) Identifies and provides evidence of a high-quality credential with viability for future careers.

8F. According to Bureau of Labor Statistics, Data Science employment opportunities are expected to grow by 31% in the next decade, so the high demand for these skills will undoubtedly continue. At the same time, it is increasingly recognized that domain expertise is critical for data science projects in applied settings. Domain expertise is especially important in engineering contexts, where the optimal solution often relies on a judicious mixture of fundamental science, engineering design heuristics, economic considerations, and data driven models. AI and data science are progressing rapidly, but most engineering problems are currently too complex for a pure AI/data science approach. We believe the most fruitful skillset, at least for the near future, is a mixture of chemical engineering foundations with proficiency in state-of-the-art data science tools. We further anticipate that students with this unique training will ultimately lead the industry in all aspects of chemical process automation and analysis.

Currently, there is no combined Chemical Engineering + Data Science program at the BS level anywhere in the world. We believe the University of Illinois can be the first to offer this unique major, and that it will draw students from across the nation. We have been careful not to promise ChemE+DS program, but discussions with prospective students and parents suggest that a ChemE+DS program would indeed be a desirable major. Computer Science at the University of Illinois at Urbana-Champaign receives approximately 10,000 applicants per year, and admits only 10% of these applicants. Data Science is a major portion of their curriculum and in reciprocal fashion, Computer Science courses are a major portion of all X+DS degrees.

We stress that our principal goal is to offer an innovative major that will prepare our students for a changing workplace. However, the ChemE+DS program will undoubtedly also help us recruit top engineering talent at the undergraduate level.

b) Department/Program Evidence of a High-Quality Credential with Viable Future Careers

Illinois is a lead in science and technology research and development, making it an ideal state for data scientists to land high powered, high paying jobs. In 2016, data scientists working in Illinois' major cities earned an annual starting salary between $80,000 and $190,000 on average. The thriving tech base is largely attributed to the state's elite research centers, international institutes, and innovative laboratories including:

- Argonne National Laboratory
- Fermi National Accelerator Laboratory
- National Center for Supercomputing Applications
- Gas Technology Institute
- National Center for Food Safety & Technology

• National Center for Food Safety & Technology
• USDA National Center for Agriculture Utilization Research

Major Illinois-based employers of Chemical Engineers and Data Scientists include:

• BP facilities including research offices and Whiting Refinery
• Archer-Daniels-Midland Headquarters and numerous Illinois facilities
• Abbott Laboratories
• AbbVie Pharmaceuticals
• ConAgra Brands
• Accenture Consulting

There is little we can do to influence students' decisions and life-plans post-graduation. Moreover, the nationwide demand and intense competition for our graduates is a point of pride in Chemical Engineering. However, the technology sector in Illinois, including data science positions, is growing. The region encompassing Chicago, known as the Technology and Research Corridor, is home to numerous other tech businesses, scientific institutes, government agencies, logistics companies, colleges and universities, and international firms like Microsoft, McDonald's, and Toyota. Employment opportunities in Illinois tend to offer comparable salaries to those in tech hubs like Silicon Valley and Seattle, but with a significantly lower cost of living.

Explain how the program engaged with business and industry in its development and how it will spur the state's economy by leveraging partnerships with local, regional, and state industry, business leaders and employers.

8G. The University of Illinois Urbana-Champaign has strong partnerships with business and industry through the Discovery Partners Institute (DPI) and the Illinois Innovation Network (IIN). DPI's Tech Talent Lab and immersion programs engage students with Chicago's technology workforce, fostering connections with regional employers, research teams, nonprofits, and startups. The university-industry links promote employment and talent retention in the area. IIN enhances the student experience through short-term boot camps focused on essential topics like artificial intelligence, data science, and entrepreneurship, cultivating interest and providing a solid foundation for future studies in these areas.

The Research Park offers industry-focused research and internships. It employs 800 year-round interns, allowing UIUC undergraduate and graduate students to work part-time on campus while remaining full-time students. It hosts more student workers than any other peer US university research/tech park. Students receive highly competitive wages for their specialized skills in fields like computer science, data analytics, engineering, business development, and human resources. Many interns are classified as Federal Work-Study participants. Research Park internships enhance employment prospects by expanding professional networks, building portfolios, and developing leadership skills.

Describe how the proposed program will expand access and opportunities for students through high-impact practices including research opportunities, internships, apprenticeships, career pathways, and other field experiences.

8H. An example at DPI is the City Scholars program, which pairs top engineering students with Chicago tech companies for semester-long internships. Engineering City Scholars work 20 hours per week at a paid internship with Chicago tech companies, making connections and building a competitive career-focused resume.

As noted in the previous response, the Research Park expands access and opportunities for students by employing 800 interns year-round in part-time research opportunities and career-relevant internships, allowing University of Illinois Urbana-Champaign undergraduate and graduate students to work on campus and be enrolled as full-time students.

In an effort to establish or enhance sustainable outreach and partnerships with PreK-12 schools, the Chancellor at the University of Illinois Urbana-Champaign established the position of Associate Chancellor for PreK-12 Initiatives in August 2021. This new position creates partnerships with superintendents statewide as well as identifies and partners with key education stakeholders to attract and retain undeserved and underrepresented students. It allows us to rethink and enhance the high school to college pipeline in Illinois by partnering with organizations such as Chicago Scholars, Hope Chicago, the Discovery Partners Institute (DPI), Illinois Innovation Network (IIN), and the Jackie Joyner-Kersee Foundation. Hope Chicago, for example, works with Chicago Public School graduates to ensure they have the financial and wraparound supports necessary to be successful in obtaining a degree by providing a student success program, career services, alumni outreach, and program performance goals.

This new initiative reconceptualizes the important role higher education must play in ensuring Illinois learners gain the confidence and comprehension for college. The ultimate goal of this initiative is to ensure that the University of Illinois Urbana-Champaign has developed structural outreach and partnerships to systemically close persisting opportunity gaps in our state’s school systems.

The Office of Undergraduate Research (OUR) is guided by the philosophy that all Illinois undergraduate students should learn about current disciplinary research, take part in research discussions, and be exposed to research experiences in their regular coursework. Furthermore, where practical, an advanced research experience should be among the capstone options in all major programs of study. Undergraduate research opportunities should be designed to support the pedagogical goals and the research mission of the university. To achieve its mission, OUR seeks to: 1) inspire students and faculty to collaborate on research projects driven by mutual interests by fostering a research mentoring environment that encourages and rewards collaboration; 2) disseminate best practices and models for undergraduate research to campus stakeholders; 3) assist in the development and evaluation of curricular and co-curricular structures that support undergraduate research; 4) encourage the creation of new opportunities for undergraduate research on campus and 5) coordinate and

new opportunities for undergraduate research on campus and 3) coordinate and nurture undergraduate research efforts across academic units on campus.

College, department, and program level high-impact practices

The presence of a substantial research or discovery experience is an integral part of the X +DS degree initiative at UIUC. Akin to the BS in Accountancy + DS and BS in Finance + DS, the curriculum of the BS in Business + DS also involves such an experience. One of the most important skills a student will gain in the BS in Business +DS will be the ability to present data in meaningful ways. A meaningful research and experience is as much a pillar of this degree program as both the core coursework in Data Science and the area of business specialization. This capstone experience can be fulfilled through BUS 301, listed in the Business Core curriculum. This course is an active learning, real-client experience that will allow students to join their data science skills with their business skills.

Explain how the proposed program will expand its models of teaching and learning, research, and/or public service and outreach that provide opportunity for students to succeed in the work of the future.

8I. Based in the College of Agricultural, Consumer and Environmental Sciences, U of I Extension works with all colleges and units of the University of Illinois Urbana-Champaign. Extension's core program areas are Agriculture and Natural Resources, Family and Consumer Sciences, Youth Development, Community and Economic Development, and Outreach and Innovation Initiatives. More than 1.5 million Illinois residents take part in University of Illinois Extension programs each year, including nearly 200,000 who participate in 4-H youth programs. Communities are directly served by Extension staff in 27 units located throughout Illinois. Extension educators in local offices and specialists located at the university develop and deliver in-depth programming locally, at regional venues, and through distance-learning technologies.

College, department, and program expansion of models

As noted in previous passages, competence in Data Science very much correlates with the work of the future. The vast amounts of data that have been acquired by private and public organizations over the last decade involve the possibilities to broadly improve the welfare of our state and the nation. Yet, the number of workers who are trained in the skills to analyze this vast amount of data and provide appropriate future directions for business and governments remains insufficient. This proposed program will train the workers of tomorrow who will be able to make sense of the digitization of our world and thereby provide substantial gains for the State of Illinois.

Beyond workforce need, describe how the program broadly addresses societal needs (e.g., cultural or liberal arts contribution, lifelong learning of Illinois residents, or civic participation).

8J. Data Science has the potential to improve both, standard of life and quality of life in many ways. It can help people make better decisions, solve problems, and discover new insights. It also has the potential to help us solve some of the world's most pressing problems.

Nonprofit organizations, like private corporations, may use data analytics tools to analyze information gathered during operations. In a survey of 460 nonprofit professionals, 90% said their organizations are collecting data, 46% said their data is spread across multiple systems and software platforms, and 50% said they use software to collect and analyze data as part of their email programs and donor management processes. In a separate Salesforce survey of over 450 nonprofit professionals, 53% collect program data, 47% analyze program data, 46% track the effectiveness of programs, and 41% quantify the overall impact of programs.

Government agencies gather data for a better understanding and growth of the nation and its well-being. They get public sector data like housing, health care, education, and national security. They also bring this through census data, labor and employment statistics, finance data, meteorological data, and geographic data.

Current data analytics methods increase the accuracy of social and economic forecasting. Yet government officials have difficulty accessing the data they want for their prediction models.

One of the more visible data-driven organizations is Change.org, a website that runs campaigns that aim to save lives and change laws. A second example is the Food and Drug Administration (FDA), which announced plans to utilize data analytics to combat the opioid crisis. Another example of data-driven organizations in action, Community Technology Alliance (CTA), was founded to develop data-driven solutions to poverty and homeless. The platform Ginger.io uses data to provide behavior health coaching, therapy, and self-led guides and assessments.

A Thriving Illinois:
Higher Education
Paths to Equity,
Sustainability, and
Growth - Attach
Documents

Program Description and Requirements

Illinois Administrative Code:

1050.30(b)(1) A) The caliber and content to the curriculum assure that the objectives of the unit of instruction will be achieved; B) The breadth and depth of the curriculum are consistent with what the title of the unit of instruction implies; C) The admission and graduation requirements for the unit of instruction are consistent with the stated objectives of the unit of instruction.

1050.30(b)(3): Appropriate steps shall be taken to assure that professional accreditation needed for licensure or entry into a profession as specified in the objectives of the unit of instruction is maintained or will be granted in a reasonable period of time.

1050.50 (a)(2)(C) Requirement for Programs in which State Licensure is Required for Employment in the Field: In the case of a program in which State licensure is required for employment in the field, a program can be found to be in good standing if the institution is able to provide evidence that program graduates are eligible to take the appropriate licensure examination and pass rates are maintained as specified in the objectives of the unit of instruction. If there is no such evidence, the institution shall report the program as flagged for review.

Program Description

Provide a description of the proposed program and its curriculum, including a list of the required core courses and short ("catalog") descriptions of each one. (This list should identify all courses newly developed for the program).

Provide Program Description here:

We propose a degree plan that combines a strong foundation in chemical engineering with training in data science principles, techniques, and practices. The program includes a traditional core sequence in chemical engineering classes with additional data science coursework requirements (comparable to a minor) and a data science practicum. The proposed degree is comprised of three different components:

1. The data science core coursework (44 hours)
a. This coursework is comprised of:
i. One (1) course from Statistics (STAT 207)
ii. Two (2) courses from Computer Science (CS 277 and CS 101)
iii. Two (2) courses from the iSchool (IS 467 and IS 477)
iv. Five (5) courses from Mathematics
v. ChBE 411
vi. ChBE 412
vii. CS 307 or ChBE 413
2. The coursework in the area of specialization (65 hours)
3. Discovery experiences (ChBE 415, 3 hours)

Attach Program Description Files if needed	ChemE + DS Curriculum with Course Descriptions 11-27-23.docx

Graduation Requirements

Provide a brief narrative description of all graduation requirements, including, but not limited to, credit hour requirements, and, where relevant, requirements for internship, practicum, or clinical. For a graduate program, summarize information about the requirements for completion of the thesis or dissertation, including the thesis committees, and the final defense of the thesis or dissertation. If a thesis or dissertation is not required in a graduate program, explain how the functional equivalent is achieved.

The requirements in total constitute 132 hrs. Students must complete the Campus General Education requirements including the campus general education language requirement.

The total credit hours, 132, are in alignment with all other undergraduate degrees available from the Chemical and Biomolecular Engineering Department and are necessary to ensure the curriculum complies with the standards necessary for the Accreditation Board for Engineering and Technology (ABET) accreditation

Departmental distinction: To graduate with distinction requires a specified minimum grade point average in all Computer Science, Statistics, Information Science, and Mathematics courses listed below. A GPA of 3.25 is required for Distinction, 3.5 for High Distinction, and 3.75 for Highest Distinction.

Specialized Program Accreditation

Describe the institution’s plan for seeking specialized accreditation for this program. Indicate if there is no specialized accreditation for this program or if it is not applicable.

We will seek ABET accreditation for the ChemE+DS degree program. Note that ABET accreditation does not require assessments for every course. We will seek accreditation of ChemE+DS mainly based on assessments of the Chemical Engineering components. The core components of the Chemical Engineering degree remain complete in the ChemE+DS proposal and these are already being assessed. The only potential challenge in accreditation will be to gain approval for some +DS core requirements that are “engineering design” electives. We will attempt to justify this designation for CS 307, CS 277, and IS 467. We only need to successfully gain approval for engineering design elective status in one of these courses to meet accreditation requirements. We do not anticipate a need for any assistance from Computer Science, Statistics, Math, or Information Sciences in this effort.

Licensure or Certification for Graduates of the Program

If this program prepares graduates for entry into a career or profession that is regulated by the State of Illinois, describe how it is aligned with or meets licensure, certification, and/or entitlement requirements.

This does not apply to this program.

Plan to Evaluate and Improve the Program

Describe the program's evaluation plan.

Learning objectives and student achievement will be thoroughly assessed as part of the standard engineering accreditation process. Specifically, the proposed degree program will be evaluated for ABET accreditation on three or six-year intervals, like other engineering degrees on campus. ABET sets eight general criteria:

1) Student performance must be monitored and students must be advised regarding career and curriculum matters to ensure graduates attain the program objectives.

2) Program educational objectives must be consistent with the institutional mission, published, and periodically reviewed by an advisory board.

3) Student outcomes required by ABET include a prescribed list of seven abilities including communication, and professional/ethical skills.

4) Continuous improvement must be demonstrated through regular assessment of student outcomes and documented efforts to use assessment findings toward program improvement.

5) Curriculum: ABET sets minimum credit hour requirements on math and basic science, on engineering courses, on broad educational courses, and on capstone design.

6) Faculty members must be of sufficient number and competence to cover all program curricula.

7) Facilities including classrooms, offices, and equipment must be adequate to support student outcomes.

8) Institutional support must be adequate to ensure program quality and continuity.

Chemical and Biomolecular Engineering (ChBE) is an ABET accredited program at the University of Illinois. The ChBE department believes that continued accreditation is important for the long-term success of our program and our graduates. All eight criteria above are already being evaluated by the ChBE department. Institutional support, adequate facilities, qualified faculty, and academic advising/career services are already in place. Quantitative assessments, based on each of the student outcomes and learning objectives are performed once per academic year in each of the core engineering classes. Beyond serving as a step toward accreditation, the assessments are genuinely used to identify areas for program improvement.

Plan to Evaluate and Improve the Program
Attachments

Budget Narrative

Fiscal and Personnel Resources

Illinois Administrative Code: 1050.30(a)(5): A) The financial commitments to support the unit of instruction, research or public service are sufficient to ensure that the faculty and staff and support services necessary to offer the unit of instruction, research or public service can be acquired and maintained; B) Projections of revenues necessary to support the unit of instruction, research or public service are based on supportable estimates of state appropriations, local tax support, student tuition and fees, private gifts, and/or governmental grants and contracts.

Budget Rationale

Provide financial data that document the university's capacity to implement and sustain the proposed program and describe the program's sources of funding.

Is the unit's (Department, College, School) current budget adequate to support the program when fully implemented? If new resources are to be provided to the unit to support the program, what will be the source(s) of these funds? Is the program requesting new state funds? (During recent years, no new funds have been available from the state (IBHE) to support new degree programs).

Currently, the CHBE department's budget, faculty and resources have been able to, at its peak enrollment, adequately support 700 students in our program. Our enrollment is currently at 500 students, assuring us that the implementation of this program will not put a strain on any of the program's budgetary resources.

Faculty Resources

Will current faculty be adequate to provide instruction for the new program or will additional faculty need to be hired? If additional hires will be made, please elaborate.

Current faculty will be adequate to provide new instruction for the new program and no new faculty will be needed to implement this program.

Please address the impact on faculty resources including any changes in numbers of faculty, class size, teaching loads, student-faculty ratios, etc.

The formal math requirements in the ChemE+DS degree are essentially the same as those of the ChBE degree. However, beyond the usual ChBE requirements, ChemE+DS will also require rigorous training in statistics, informatics, and programming concepts. These include coursework in statistics, computer science, industrial engineering, the iSchool, and new courses on computational methods and data science specifically for ChBE. Two of the three ChBE electives that will be options for ChemE+DS students have already been offered multiple times. The third course is Data Science for Chemistry and Engineering, which we are planning to offer in Spring of 2024.

Our intent is for the ChemE+DS degree option to make ChBE more competitive in undergraduate student recruiting. We hope the effect is to increase applicant numbers so that we can increase enrollment while also being more selective. Our undergraduate enrollment can increase by as much as 15% without impacting the laboratory courses. The increased enrollments should not affect student to faculty ratio in ChBE. Faculty teaching loads and resources will also be unaffected by the implementation of this new program.

Describe how the unit will support student advising, including job placement and/or admission to advanced studies. Will current staff be adequate to implement and maintain the new program or will additional staff be hired? Will current advising staff be adequate to provide student support and advisement, including job placement and or admission to advanced studies? If additional hires will be made, please elaborate.

We have confirmed with the SCS Advising team (Patricia Simpson and Wolali Dedo) that they can accommodate the additional ChemE+DS students in the current advising model. No additional advising resources are needed.

Are the unit’s current facilities adequate to support the program when fully implemented? Will there need to be facility renovation or new construction to house the program?

Yes, the unit’s current facilities are adequate to support the program. No new construction to our current facilities (Located mainly in Roger Adams Lab (located at 600 South Mathews Ave. Urbana, IL 61801) and in Noyes Laboratory (located at 505 South Mathews Ave. Urbana, IL 61801)) will be needed due to the addition of this program to our department.

Library Resources

Describe your proposal's impact on the University Library's resources, collections, and services. If necessary please consult with the appropriate disciplinary specialist within the University Library.

Current library collections, resources and services are sufficient to support this program. There is no financial impact on the Library for the creation and sustainability of this program. The university library already owns all the course books and materials necessary.

Summarize information about library resources for the program, including a list of key textbooks, a list of key text and electronic journals that will support this program, and a short summary of general library resources of the University that will be used by the program’s faculty, students, and staff.

No additional library resources will be needed for this course, and none of the courses associated with the +DS have textbooks and will not have use of any particular key texts or electronic journals for support. All of the courses required of this program are already existing (except for CHBE 415, which does NOT require a textbook or additional texts/resources), so no new resources are needed. Here are the current textbooks that are being used by the CHBE Dept and, in concurrence, the ChemE+DS program.

Advanced Engineering Mathematics
An Introduction to Statistical thermo-dynamics
Analysis of transport Phenomena
Analysis, Synthesis, and Design of Chemical Processes
Analysis, Synthesis, and Design of Chemical Processes
Applied Statistics for Engineers and Scientists
Basic Principles and Calculations in Chemical Engineering
Binder- ChBE221 Hammack
BIOFUELS Biotechnology, Chemistry and Sustainable Development
Bioprocess Engineering Basic Concepts
Bioprocess Engineering Basic Concepts
Concepts of Modern Catalysis and Kinetics
Concepts of Modern Catalysis and Kinetics
Effective Scientific Communication The Other Half of Science
Electrochemical Engineering
Elementary Principles of Chemical Processes
Elements of Chemical Reaction Engineering
Elements of Chemical Reaction Engineering
Essentials of Computational Chemistry: Theories and Models
Fabrication Engineering At The Micro and Nanoscale
Fabrication Engineering At The Micro and Nanoscale (Instructor's Manual)
Fault Detection and Diagnosis in Industrial Systems
Fundamentals of Momentum, Heat, and Mass Transfer
Fundamentals of Momentum, Heat, and Mass Transfer
Intermolecular and Surface Forces
Introduction to BIOFUELS
Introduction to Biotechnology
Introduction to Chemical Engineering Kinetics & Reactor Design
Introduction to Chemical Engineering Thermodynamics
Introduction to Chemical Engineering Thermodynamics
Introduction to Polymer Chemistry
Minding the Machines Preventing Technological Disasters
Molecular Biotechnology Principles and Applications of Recombinant DNA
Molecular Biotechnology Principles and Applications of Recombinant DNA
Molecular Biotechnology Principles and Applications of Recombinant DNA
Nanostructures and Nanomaterials: Synthesis, Properties and Applications

Nanostructures and Nanomaterials: Synthesis, Properties and Applications
Physics in Biology and Medicine
Polymer Chemistry
Principles of Statistics for Engineers and Scientists
Process Control Designing Processes and Control Systems for Dynamic Performance
Process Design and Control
Scientific Writing and Communication: Papers, Proposals, and Presentations
The Agenda Mover When Your Idea Is Not Enough
Thermodynamics And An Introduction To Thermostatistics
Transport Phenomena in Biological Systems
Transport Processes and Separation Process Principles (Includes Unit Operations)
Unit Operations of Chemical Engineering
Viscoelastic Properties of Polymers
Writing in Engineering A Brief Guide

Are any sources of funding temporary (e.g., grant funding)? If so, how will the program be sustained once these funds are exhausted?

No sources of funding are temporary.

Budget Narrative
Fiscal and
Personnel
Resources
Attachments

Personnel Budget

Please complete all lines below; all fields are required. For fields where there is no anticipated cost or need, enter 0 or NA.

Category Year One Year Five Notes

Faculty (FTE)

Faculty FTE Year1	Faculty FTE Year 5	Faculty FTE Notes
0	0	NA

Faculty ($)

Faculty Year 1	Faculty Year 5	Faculty Notes
0	0	NA

Advising Staff ($)

Advising Staff Year 1	Advising Staff Year 5	Advising Staff Notes
0	0	NA

Graduate
Students ($)

Graduate Students	Graduate Students	Graduate Students Notes

Year 1	Year 5	
0	0	NA

Other Personnel Costs

Other Personnel Costs Year 1	Other Personnel Costs Year 5	Other Personnel Costs Notes
0	0	NA

Budget Narrative Attachments

Facilities and Equipment

Illinois Administrative Code: 1050.30(a)(4): A) Facilities, equipment and instructional resources (e.g., laboratory supplies and equipment, instructional materials, computational equipment) necessary to support high quality academic work in the unit of instruction, research or public service are available and maintained;

B) Clinical sites necessary to meet the objectives of the unit of instruction, research or public service;

C) Library holdings and acquisitions, owned or contracted for by the institution, that are necessary to support high quality instruction and scholarship in the unit of instruction, research and public service, are conveniently available and accessible, and can be maintained.

Describe the facilities and equipment that are available, or that will be available, to develop and maintain high quality in this program. Summarize information about buildings, classrooms, office space, laboratories and equipment, and other instructional technologies for the program.

FACILITIES:

The data science core will be delivered by the i-School and the departments of Computer Science, Mathematics, and Statistics. The i-School and the Department of Computer Science are housed in buildings that provide classroom and lab spaces for students to engage with data science. The university has just completed construction of the Campus Instructional Facility and the Siebel Center for Design that provide outstanding modern research in data science. The university is currently renovating and rebuilding the buildings that house Mathematics and Statistics; the renovation provides for increased classroom and lab spaces for instruction and student research. Together these constitute excellent facilities for delivering the X + DS programs.

The Chemical Engineering courses are offered in classroom space assigned by the Office of the Registrar Catalog Management and Section Scheduling (CMSS), and are mainly located in Noyes Lab (505 South Mathews Ave. Urbana, IL 61801) and Roger Adams Lab (600 South Mathews Ave., Urbana, IL 61801). Sufficient classroom space is available and includes classroom space in the Campus Instructional Facility (1405 West Springfield Ave, Urbana, IL 61801).

EQUIPMENT:

BioFlo 3000 Bioreactor/Fermentation Experiment
Students characterize yeast cell growth by measuring cell, glucose, and ethanol concentration at different substrate and nutrient concentrations.
Equipment includes: temperature controlled bioreactor/fermenter, temperature bath and shaker, UV-Vis Spectrophotometer (plate reader), ethanol and glucose assay kits, Nikon optical microscope, refrigerator/freezer, balances, centrifuges, and supporting equipment such as glassware, micropipettors, etc.

Haake Polymer Extrusion Experiment
Students characterize and optimize the production of polyethylene thin films by varying cooling and inflation air, screw speed, and take off speed.
Equipment includes: Temperature-zone controlled polymer extruder with annular die and compression rollers, 2 precision calipers, 2 anemometers.

CSTR/PFR Experiment
Students determine kinetic data for a mildly exothermic reaction. Kinetic data are obtained from measurements of conductivity, pH, and titrations. Students characterize and develop theoretical models for prediction of conversion.
Equipment includes: Temperature controlled jacketed BSTR/CSTR, PFR, two peristaltic pumps, conductivity meter/probe, pH meter/probe, burette, external temperature bath.

Armfield Liquid-Liquid Extraction Experiment
Students study operating conditions for extraction of a contaminant (tert-butanol) from an organic phase (mineral oil) into water. Students develop models for droplet velocity and mass transfer rates from the droplet to the water phase.
Equipment includes Liquid-liquid extraction column, water pump, solvent pump, refractometer for concentration measurement,.

BP Continuous Distillation
Students perform McCabe-Thiele and mass balance analyses to determine effect of operating conditions (feed location, feed flow rate, reflux ratio) for an operating column consisting of 5 trays and a steam reboiler.
Equipment includes: 1 ½ story five sieve tray glass column, direct overhead condenser, large thermosyphon reboiler, feed tanks, four pumps, solenoid valves for sample collection, ball valves for feed location selection, control panel for controlling flows and viewing temperature readouts, and a PID level control system.

Pignat Tray Dryer
Students analyze the drying curves and heat and mass transfer processes of different materials such as clay pellets and cotton balls that have been moistened with water.
Equipment Includes: Pignat tray dryer with heater and fan, a balance to measure the weight of the sample, and built-in temperature and relative humidity. Data from additional probes for measuring the sample temperature, gas velocity, and temperature and humidity at different locations in the oven are collected using a small data acquisition.

Undergraduate Research Equipment:
The list below is only a subset of the vast array of equipment available to undergraduates while they are performing research in the labs of our faculty.

Eppendorf Mastercycler PCR Thermocycler
Thermo Scientific Max Q4000 Incubator
Thermo Scientific NAPCO series 8000WJ incubator
BioRad MicroPulser electroporator
GE Healthcare AKTA FPLC
Brookfield DV-II+ Pro viscometer
Olympus IX-71 inverted fluorescence microscope
VWR VistaVision Inverted microscope
VirTis Genesis freeze dryer
Anprolene AN74i EtO sterilizer
Napco 8000WJ CO2 incubators
Leica DM IL lED inverted microscope with digital camera
Bio-Rad S1000 thermocycler
Tecan M200 microplate reader
Applied Biosystems 7900HT Fast Real-time PCR machine
Leica DMI4000B inverted fluorescence microsope
Zeiss Axiovert 200M epifluorescence scope

Zeiss LSM710/700 confocal microscopes with spectral deconvolution capacity
Olympus IX71 outfitted with an Andor Technology Revolution Spinning Disc system
Harvard Scientific dual syringe pumps
GE Typhoon slide scanner
Heidolph Hei-VAP rotary evaporator
Eppendorf 5810R benchtop centrifuge
Fisher Scientific Model 100 Sonic Dismembrator
Leica DMIL inverted microscope equipped with a Leica D-LUX 3 CCD camera
Tecan Infinite 200 Pro microplate reader
MTS Insight mechanical testing system
Perkin Elmer Diamond differential scanning calorimeter (DSC)
Jelight Model 20 UV light box
Custom-made ultra-high vacuum chambers
Physical Electronics Auger/LEED Spectroscopy
Florida Object Oriented Process Simulator (FLOOPS)
3 Liter MDC vacuum chamber
Multiple Alcatel Rough vacuum pumps
MKS 247 – Mass Flow Controller (MFC) unit
Edwards RV12 rotary pump
Harvard Apparatus 55-2222 syringe pump
Branson 2510 sonicator
TA Instruments SDT Q600 thermogravimetric analyzer (TGA)
Millipore Direct-Q 5 Ultrapure water system

Undergraduate Research Software:

The list below is a subset of the software available to undergraduates while they are performing research in the labs of our faculty.

Canva
Grammarly
Smug Mug
SnapGene
Amber 22
SLACK
BioRender
Folding@Home
CHEMCAD
Chemstation
Minitab
COMSOL

Will the program require new or additional facilities or significant improvements to already existing facilities?

No

Will the program need additional technology beyond what is currently

available for the unit?	No
Are there other costs associated with implementing the program?	No

Facilities and Equipment Attachments

Equipment and Software List.docx

Faculty and Staff

Illinois Administrative Code: 1050.30(a)(3): A) The academic preparation and experience of faculty and staff ensure that the objectives of the unit of instruction, research or public service are met; B) The academic preparation and experience of faculty and staff, as evidenced by level of degrees held, professional experience in the field of study and demonstrated knowledge of the field, ensure that they are able to fulfill their academic responsibilities; C) The involvement of faculty in the unit of instruction, research or public service is sufficient to cover the various fields of knowledge encompassed by the unit, to sustain scholarship appropriate to the unit, and to assure curricular continuity and consistency in student evaluation; D) Support personnel, including but not limited to counselors, administrators, clinical supervisors, and technical staff, which are directly assigned to the unit of instruction, research or public service, have the educational background and experience necessary to carry out their assigned responsibilities.

Describe the personnel resources available to develop and maintain a high quality program, including faculty (full- and part-time, current and new), staff (full- and part-time, current and new), and the administrative structure that will be in place to oversee the program. Also include a description of faculty qualifications, the faculty evaluation and reward structure, and student support services that will be provided by faculty and staff.

Faculty (tenure track):

Ying Diao, Assoc Professor, PhD
Damien Guironnet, Assoc Professor, PhD
William Hammack, Professor, PhD
Brendan Harley, Professor, PhD
Jonathan Higdon, Professor, PhD
Paul Kenis, Professor, PhD
Hyun Joon Kong, Professor, PhD
Mary Kraft, Professor, PhD
Alexa Kuenstler, Asst Professor, PhD
Deborah Leckband (75%), Professor, PhD
Alexander Mironenko, Asst Professor, PhD
Baron Peters, Professor, Director of Undergraduate Studies, PhD
Christopher Rao, Professor, Department Head, PhD
Simon Rogers, Assoc Professor, PhD
Charles Schroeder (25%), Professor, PhD
Diwakar Shukla, Assoc Professor, PhD
Theresa Schoetz, Asst Professor, PhD
Charles Sing, Professor, Director of Graduate Studies, PhD
Xiao Su, Asst Professor, PhD
Hong Yang, Professor, Director of MEng in Leadership, PhD
Huimin Zhao, Professor, PhD

Specialized Faculty (non tenure track):

Joachim Floess, Senior Lecturer, PhD
Uzoma Monye, Teaching Asst Professor, PhD
Ryan Mullen, Teaching Asst Professor, PhD
Sara Pedron Haba, Research Asst Professor, PhD

0% Appointments and Affiliates:

Rohit Bhargava, Professor of Bioengineering, PhD
Paul Braun, Professor of Materials Science & Engineering, PhD
Qian Chen, Assoc Professor of Materials Science & Engineering, PhD
Christopher Evans, Asst Professor of Materials Science & Engineering, PhD
Hee-Sun Han, Asst Professor of Chemistry, PhD
Nicholas Jackson, Asst Professor of Chemistry, PhD
Kenneth Schweizer, Professor of Materials Science & Engineering, PhD
Antonia Statt, Asst Professor of Materials Science & Engineering, PhD

Antonia Statt, Asst Professor of Materials Science & Engineering, PhD

Support Staff:

Wendy Balthazor, Assoc Director of Admin and Finance
Christine Bowser, Office Administrator
Austin Dallas, Coordinator of Admin and Finance
Rebecca Dawson, Office Support Associate
Connie Knight, Coordinator of Graduate Programs
Anne McKinney, Coordinator of MEng Leadership Program
Jadii Rodgers, Office Support Specialist
Kristina Shidlauski, Assoc Director of Communications
Kathy Thomas-Stagg, Coordinator of Undergraduate Programs

Faculty Evaluation (Tenure Track):

Tenure-track faculty at the University of Illinois are evaluated annually based on activity reports created in accordance with the Office of the Provost, Communication #9: Promotion and Tenure. The reports include comprehensive sections on research, teaching, and service, as well as an optional report on activities related to diversity, equity, and inclusion. The same report is the basis for tenure and promotion; at that stage, it is accompanied by letters from external reviewers and an assessment for each section, as well as an overall assessment from the unit executive officer. https://provost.illinois.edu/policies/provosts-communications/communication-9-promotion-and -tenure/

Specialized Faculty Evaluation (Non Tenure Track)

Non-tenure-track faculty at the University of Illinois are evaluated annually in accordance with the Office of the Provost, Communication #25: Guidelines for Specialized Faculty Holding Non-Tenure System Positions https://provost.illinois.edu /policies/provosts-communications/?page_id=168 and Communication #26: Promotion to Teaching, Research, or Clinical Associate or Full Professor Titles https://provost.illinois.edu/policies/provosts-communications/?page_id=169

Summarize the major accomplishments of each key faculty member, including research/scholarship, publications, grant awards, honors and awards, etc. Include an abbreviated curriculum vitae or a short description.

Please see the attached file for key faculty bios and accomplishments.

Faculty and Staff
Attachments
Complete list of Faculty Bios - use for CIM proposal.pdf

HLC Section

Credit Hours

Existing or repackaged curricula (Courses from existing inventory of courses):	Number of Credit Hours: 95	125 Percent of Total:
Revised or redesigned curricula (Courses for which content has been revised for the new program):	Number of Credit Hours: 0	0 Percent of Total:
New curricula (Courses developed for the new program that have never been offered):	Number of Credit Hours: 5	7 Percent of Total:
Total Credit Hours of the Program:	Number of Credit Hours:	132 Percent of Total:

100

New Faculty Required

Will new faculty expertise or new faculty members be needed to launch this program?

No

Please explain existing coverage:

No new faculty members will be required to launch this program.

Additional Funds

Will the proposed program require a large outlay of additional funds by the institution?

No

Institutional Funding

Please explain institutional funding for proposed program:

No additional institutional funding is needed for the proposed ChemE + DS program.

EP Documentation

EP Control Number	EP.24.111
Attach Rollback/Approval Notices	IS course approval.pdf
This proposal requires HLC	No

inquiry

DMI Documentation

Attach Final Approval Notices

Banner/Codebook Name
EP.24.111

Program Code:

Minor Code	Conc Code	Degree Code	Major Code

Senate Approval Date

Senate Conference Approval Date

BOT Approval Date

IBHE Approval Date

HLC Approval Date

DOE Approval Date

Effective Date:

Attached Document

Justification for this request

Program Reviewer Comments

Brooke Newell (bsnewell) (10/13/23 10:24 am): Rollback: Email sent to Chris, Baron, Kathy, Andrea and Stephen

Brooke Newell (bsnewell) (11/15/23 8:46 am): Rollback: Email sent to Kathy, Baron, Chris R., AJ Schmidt, Andrea, and Stephen

Brooke Newell (bsnewell) (12/01/23 11:11 am): Rollback: Per discussion with Kathy Thomas-Stagg

Barbara Lehman (bjlehman) (04/19/24 11:20 am): Rollback: attachments

Key: 1204

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

College of Liberal Arts & Sciences
Department of Chemistry
109 Noyes Laboratory, Box D-1, MC-712
600 S. Mathews Ave.
Urbana, IL 61801-3602

August 9, 2023

Professor Baron Peters
Director of Undergraduate Studies, Department of Chemical and Biomolecular Engineering

Dear Professor Peters,

The Department of Chemistry (CHEM) is supportive of the proposed new program in ChemE + Data Science. CHEM is happy to provide access to the following, for a potential addition of 10-40 students per course per year:

- CHEM 202, Accelerated Chemistry I, with accompanying laboratory, CHEM 203, Accelerated Chemistry Lab I.
- CHEM 204, Accelerated Chemistry II, with accompanying laboratory, CHEM 205, Accelerated Chemistry Lab II.
- CHEM 236, Fundamental Organic Chem I
- CHEM 237, Structure and Synthesis (a laboratory course)
- CHEM 442, Physical Chemistry I
- CHEM 420, Instrumental Characterization
- CHEM 315, Instrumental Chem Systems Lab (a laboratory course)

In the event that the numbers grow far larger than this, we may ask your Department to sponsor discussion or laboratory sections, as other units do (these sections usually have one teaching assistant per 12-24 students).

Congratulations on your exciting proposed program. If you need more information, please contact me at 333-7680 or at murphycj@illinois.edu.

Best Regards,

Catherine J. Murphy
Head, Department of Chemistry
Larry R. Faulkner Endowed Chair in Chemistry

UNIVERSITY OF ILLINOIS
AT URBANA–CHAMPAIGN

Department of Statistics
101 Illini Hall
725 South Wright Street
Champaign, IL 61820

July 25, 2023

To Whom It May Concern,

I am writing to indicate the support of the Department of Statistics for the following proposal:

• ChemE + Data Science

This program will provide students across the university with the opportunity to study data science along with a disciplinary specialization.

The Department of Statistics supports including STAT/CS 207 or STAT 212 in the data science core curriculum. We will provide seats for ChemE + DS students in these courses starting in Fall 2024.

Sincerely,

Bo Li
Professor and Chair
Department of Statistics

telephone 217-333-2167 • *fax* 217-244-7190

chbe-ugprogramoffice

From: Grosse Perdekamp, Matthias
Sent: Wednesday, August 2, 2023 2:56 PM
To: ChBE Department Head
Cc: chbe-ugprogramoffice
Subject: RE: Course Approvals for Chemical Engineering + Data Science (ChemE + DS) Program

Hi Chris,

We certainly support your new degree in ChemE + DS and approve of the additional enrollment in 211, 212 and 214. These courses currently have up to 1,200 students. It would be helpful if you could let us know the expected annual enrollment for planning purposes. There is a number of new degree programs that will be using the three courses and we want to keep track of student count projections.

Also, please let me know if you should require a formal letter, which we will be happy to provide.

Best,
Matthias

Matthias Grosse Perdekamp
Professor and Head of the Department of Physics
Director of ACDIS the Program in Arms Control and Domestic and International Security
University of Illinois - Urbana Champaign
+1 217 333 6544, mgp@illinois.edu

From: ChBE Department Head <chbe-head@illinois.edu>
Sent: Wednesday, August 2, 2023 2:22 PM
To: Grosse Perdekamp, Matthias <mgp@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Course Approvals for Chemical Engineering + Data Science (ChemE + DS) Program

Dear Professor Matthias Perdekamp,

We are writing to formally request your department's support and approval for the inclusion of certain courses in the Physics Department’s curriculum as part of the newly proposed Chemical Engineering + Data Science (ChemE + DS) Program within the College of Engineering at the University of Illinois Urbana-Champaign (UIUC).

The ChemE + DS Program is an innovative interdisciplinary program that aims to equip our students with a comprehensive skill set that bridges the gap between traditional chemical engineering and modern data science practices. By integrating key principles from both disciplines, this program will produce graduates who are uniquely prepared to address the complex challenges of our rapidly evolving technological landscape.

To ensure the success and rigor of this program, we are seeking the collaboration of various departments across UIUC. We have identified several courses within your department that align with the objectives of the ChemE + DS Program and would greatly enhance the educational experience of our students. These courses include:

PHYS 211	University Physics: Mechanics
PHYS 212	University Physics: Elec & Mag
PHYS 214	Univ Physics: Quantum Physic

We request your department's approval to allow ChemE + DS students to enroll in these courses and count them toward their program requirements. This collaboration will not only enrich the educational experience of our students but also foster interdisciplinary connections and promote a culture of academic excellence across departments. Your support does NOT guarantee that any individual course would be offered in any given semester, nor that a position in any course would be guaranteed for a CHBE student in a given semester. If there are any courses in the table you would prefer to exclude from your approval, please make a note of those exclusions in your reply.

Many thanks for your assistance.

Chris Rao
Mentzer Professor
Head, Chemical & Biomolecular Engineering

ILLINOIS

DEPARTMENT OF COMPUTER SCIENCE
Thomas M. Siebel Center for Computer Science
201 N. Goodwin Ave.
Urbana, IL 61801-2302 USA

NANCY M. AMATO
Abel Bliss Professor and Head
2248 Siebel Center
namato@illinois.edu

August 8, 2023

To Whom It May Concern,

I am writing to indicate the strong support of the Department of Computer Science for the proposal to create a BS in Chemical Engineering + Data Science.

Blended degree programs like this have proven to be extremely popular and given the demand for data science education amongst students, this new degree will meet an urgent need.

The Department of Computer Science agrees to provide seats for students in this program in the following courses:

- CS 101: Intro to Computing for Engineering (Required for ChemE+DS)
- CS 277: Algorithms and Data Structures for Data Science (Required for ChemE+DS)
- CS 307: Modeling and Learning in Data Science (Optional for ChemE+DS)

We intend to offer CS 101 every Fall and Spring semester and CS 277 and CS 307 at least once a year to meet student demand.

Sincerely,

Nancy M. Amato
Abel Bliss Professor and Head
Department of Computer Science

From:	Newell, Melissa Allison
To:	chbe-ugprogramoffice
Cc:	chbe-ugprogramoffice
Subject:	Re: CHBE Seeking IS Course Approval for Endorsement of new ChemE + DS program and IS courses
Date:	Tuesday, August 29, 2023 3:00:01 PM
Attachments:	image002.png image003.png

Hello CHBE,

I confirmed with our program director, and we approve of these inclusions of our courses in your proposal. Please let us know if you have any questions.

Sincerely,
Melissa

MELISSA NEWELL, PHD | *Director of Undergraduate Affairs*
School of Information Sciences (iSchool) | University of Illinois at Urbana-Champaign
614 E. Daniel St., 4th Floor | Champaign, IL 61820
https://go.ischool.illinois.edu/bsis

ILLINOIS

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Date: Thursday, August 17, 2023 at 1:01 PM
To: Blake, Catherine Lesley <clblake@illinois.edu>, Newell, Melissa Allison <menewell@illinois.edu>, Diesner, Jana <jdiesner@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: CHBE Seeking IS Course Approval for Endorsement of new ChemE + DS program and IS courses

ILLINOIS

COLLEGE OF LIBERAL ARTS & SCIENCES
Department of Chemical & Biomolecular Engineering
114 Roger Adams Laboratory, MC-712
600 S. Mathews Ave.
Urbana, IL 61801

August 16, 2023

School of Information Sciences

Good afternoon,

I am writing to ask for your endorsement and future cooperation on a new ChemE+DS program. The new program will require ChBE students to take some courses in your department. We anticipate approximately 10-40 students per year will enroll in the ChemE+DS program. These students should be allowed, and in some cases will be required, to take the following courses from your department:

IS 467	Ethics and Policy for Data Science
IS 477	Data Management, Curation & Reproducibility

With approval from your department for our ChemE+DS program, along with the IS course work listed above, we would like to offer our ChemE+DS students, we would like to begin conferring ChemE+DS degrees in Spring 2024, and to have students taking these courses in pursuit of ChemE+DS degrees as early as Fall 2024. We have attached a copy of the proposal for this new degree program for your consideration. If you approve, please reply with an official statement of approval of the program and use of the IS courses listed above, and your department's cooperation.

Thank you,

Baron Peters

Baron Peters
Willian H. and Janet G. Lycan Professor
Director of Undergraduate Studies
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
217.333.3640 • chbe.illinois.edu

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Department of Mathematics, 273 Altgeld Hall
1409 W. Green St. (MC-382), Urbana, IL 60801

November 8, 2023

To whom it may concern:

I am writing to indicate the support of the Department of Mathematics for the ChemE+DS proposal. These programs will provide students across the university with the opportunity to study data science along with a disciplinary specialization.

The Department of Mathematics supports the inclusion of the following courses in these proposals:

- MATH 221
- MATH 231
- MATH 241
- MATH 257
- MATH 285
- MATH 441

We will provide seats for X+DS students in these courses to meet demand. We are currently in the practice of running MATH 220, 231, and 257 every semester, MATH 221 every fall, and MATH 227 every Spring, and expect that we will continue to do so.

Sincerely,

Vera Hur
Professor and Chair, Mathematics

From:	Sweedler, Jonathan V
To:	chbe-ugprogramoffice; Axelson, Jordan Cole; Silverman, Scott K
Cc:	ChBE Director of Undergraduate Studies; Higdon, Jonathan J L; Cox, Jenny L
Subject:	RE: Seeking Additional CHEM Course approval for new ChemE+DS program
Date:	Tuesday, November 28, 2023 11:06:17 AM

Dear Baron,

We approve the chem courses for your new ChemE + DS program. Most courses will not be an issue. However, as I had mentioned in a prior email, the addition of Chemistry 222 / 223 is currently fine but it is a course that is already close to capacity.

There are no issues at this point, but if the long-term goal is to increase the overall ChemE enrollment by 200 by bringing in +DS students, then we may ask for support to fund a TA/section if we observe that the 101-223 pipeline indeed swells beyond its current capacity due to this change.

Todd Spinner tells me that currently CHEM 222 and 223 can be hard for students to get into, especially non-majors who are trying to get into CHEM or CHBE.

Regards,

Jonathan

My working day may not be your working day. Please do not feel obligated to reply outside of your normal working hours

Jonathan V. Sweedler
(he, him, his)

James R. Eiszner Family Endowed Chair in Chemistry
Acting Head, Department of Chemistry
Professor of Neuroscience and Molecular & Integrative Physiology
Center for Advanced Study Professor
Professor of the College of Medicine, the Beckman Institute and the Institute of Genomic Biology
Editor-in-Chief, Analytical Chemistry

600 S. Mathews Ave., 63-5
Urbana IL 61801 USA
(t) 217 244 7359 jsweedle@illinois.edu https://chemistry.illinois.edu/jsweedle

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ILLINOIS

COLLEGE OF LIBERAL ARTS & SCIENCES

Department of Chemical & Biomolecular Engineering
114 Roger Adams Laboratory, MC-712
600 S. Mathews Ave.
Urbana, IL 61801

November 20, 2023
Professor Jonathan Sweedler and Professor Jordan Axelson

Professors: I am writing to ask for your endorsement and future cooperation on a new ChemE+DS program. A draft proposal for the ChemE+DS program is attached to this message. The new program will require ChBE students to take some courses in your department. These students should be allowed, and in some cases will be required, to take the following courses from your department:

CHEM 101	Introductory Chemistry
CHEM 102	General Chemistry I
CHEM 103	General Chemistry Lab II
CHEM 104	General Chemistry II
CHEM 105	General Chemistry Lab II
CHEM 222	Quantitative Analysis Lecture
CHEM 223	Quantitative Analysis Lab

Since the beginning of this process, we have already received from your department approval for the use of CHEM 202, 203, 204, 205, 236, 237, 315, 420, and 442. It wasn't until recently after we submitted our proposal for revision and review that we became aware of the need for the addition of the above course, and, in turn, the written approval of their uses by the CHEM department. With approval from your department, we hope to begin conferring ChemE+DS degrees in Spring 2025, and to have students taking these courses in pursuit of ChemE+DS degrees as early as Spring 2024. We ask the College of Engineering for help with ABET assessments for the +DS portions of the ChemE+DS degree. This should include data and assessment documents for all +DS math department courses.

Thank you for your time and efforts with this process. We look forward to the implementation of this degree program and your endorsement for the classes above.

Regards,
Baron Peters
William H. and Janet G. Lycan Professor and Director of Undergraduate Studies
292 Roger Adams Laboratory
baronp@illinois.edu

Courses needing approval for use in CHBE new ChemE + DS Program

From: Makela, Jonathan
To: ChBE Director of Undergraduate Studies; Hallock, Ashley
Cc: chbe-ugprogramoffice
Subject: Re: Seeking ENG course approval for new ChemE+DS Program
Date: Monday, September 11, 2023 2:29:28 PM
Attachments: image002.png
image004.png

Dear Professor Peters,

I write to acknowledge that we are looking forward to working with you to support the additional 10-40 students per year in the proposed ChemE+DS undergraduate degree program in ENG 100: Engineering Orientation. We anticipate being able to accommodate them in existing sections of this course dedicated to ChBE students, perhaps requiring the addition of one section depending on actual enrollments.

Regards,
Jonathan

JONATHAN J. MAKELA
Associate Dean for Undergraduate Programs, The Grainger College of Engineering
Abel Bliss Professor of Engineering, Department of Electrical and Computer Engineering
University of Illinois Urbana-Champaign

206 Engineering Hall
1308 W. Green St.
Urbana, IL 61801
Phone: (217) 333-2280
Fax: (217) 244-4974

http://airglow.ece.illinois.edu/

ILLINOIS

From: ChBE Director of Undergraduate Studies <chbe-dus@illinois.edu>
Date: Thursday, August 31, 2023 at 5:03 PM
To: Hallock, Ashley <ahallock@illinois.edu>, Makela, Jonathan <jmakela@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Seeking ENG course approval for new ChemE+DS Program

ILLINOIS

COLLEGE OF LIBERAL ARTS & SCIENCES
Department of Chemical & Biomolecular Engineering
114 Roger Adams Laboratory, MC-712
600 S. Mathews Ave.
Urbana, IL 61801

August 31, 2023
Professor Jonathan Makela and Ashley Hallock

Good afternoon:

I am writing to ask for your endorsement and future cooperation on a new ChemE+DS program. A *draft* proposal for the ChemE+DS program is attached to this message. The new program will require ChBE students to take some courses in your department. We anticipate approximately 10-40 students per year will enroll in the ChemE+DS program. These students should be allowed, and in some cases will be required, to take the following courses from your department:

ENG 100	Engineering Orientation

With approval from your department, we would like to begin conferring ChemE+DS degrees in Fall 2024 and to have students taking these courses in pursuit of ChemE+DS degrees as early as Spring 2024. We have attached a copy of the proposal for this new degree program for your consideration. If you approve, please reply with an official statement of approval and cooperation.

Thank you,

Baron Peters

Baron Peters

Willian H. and Janet G. Lycan Professor
Director of Undergraduate Studies
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
217.333.3640 • chbe.illinois.edu

From: Hur, Vera Mikyoung
To: Ray, Andrea Lynne
Subject: Re: *NEED RESPONSE ASAP* - Chemical Engineering + DS, BS
Date: Friday, March 29, 2024 11:01:01 AM
Importance: High

I approve the amendment.

> On Mar 29, 2024, at 10:19 AM, Ray, Andrea Lynne <aray@illinois.edu> wrote:
>
> Good morning!
> I am sorry for the quick turnaround, but I need a response from you ASAP. As we looked through the courses, we realized that MATH 220 was not listed on the letter as an approved course. We would like to add that course to the POS as the normal “MATH 220 or MATH 221” statement. Please respond to this email with your approval.
> Thank you and have a great weekend!
> Andrea
> Andrea Ray
> Assistant to the LAS Associate Dean for Curricula and Academic Policy
> College of Liberal Arts & Sciences
> University of Illinois at Urbana-Champaign
> 2090 Lincoln Hall, MC-448
> 702 S. Wright Street
> Urbana, IL 61801
> 217.333.2192
> www.las.illinois.edu
> <image001.png> ~~~~~~~~~~~~~~~~~~~~~~~~~~
> “Do kind things for people. Not because of who they are or what they do in return, but because of who you are.” —unknown
> ~~~~~~~~~~~~~~~~~~~~~~~~~~
> Watch your thoughts; they become words.
> Watch your words; they become actions.
> Watch your actions; they become habits.
> Watch your habits; they become character.
> Watch your character; it becomes your destiny.
> Under the Illinois Freedom of Information Act any written communication to or from university employees regarding university business is a public record and may be subject to public disclosure.
> <MATH course approval.pdf>

Sample Sequence

**The sample sequence below assumes that the student has placed into the Accelerated Chemistry courses.*

Sample Sequence for Chemical Engineering + DS, BS*

First Year			
First Semester Courses	**Hours**	**Second Semester Courses**	**Hours**
ENG 100	1	CHEM 204 (Gen Ed: NST)	3
CHEM 202 (Gen Ed: NST)	3	CHEM 205	2
CHEM 203	2	CHBE 121	1
MATH 221 or MATH 220 (Gen Ed: QR I)	4-5 (use 4)	MATH 231 (Gen Ed: QR I)	3
General Education Course (choose a *HA* course with *CS* designation)	3	PHYS 211 (Gen Ed: NST & QR II)	4
Composition I or General Education Course	3	General Education Course or Composition I	4
semester sum	16	semester sum	17
Second Year			
First Semester Courses	**Hours**	**Second Semester Courses**	**Hours**
CHBE 221	3	CHBE 321	4
MATH 241 (Gen Ed: QR II)	4	CHBE 411	3
PHYS 212 (Gen Ed: NST & QR II)	4	CS 101 (Gen Ed: QR II)	3
CHEM 236	4	MATH 257	3
CHEM 237	2	PHYS 214	2
		General Education Course (choose a *HA* course with *CS* designation)	3
semester sum	17	semester sum	18

Third Year			
First Semester Courses	**Hours**	**Second Semester Courses**	**Hours**
CHBE 421	4	CHBE 422	4
STAT 207 (Gen Ed: QR II)	4	CHBE 412	3
Math 285 or MATH 441	3	CHBE 413 or CS 307	4
CHEM 442	4	CHEM 315	2
CHEM 420	2	CS 277	4
semester sum	17	semester sum	17
Fourth Year			
First Semester Courses	**Hours**	**Second Semester Courses**	**Hours**
CHBE 424	3	CHBE 431 (Gen Ed: AC)	4
CHBE 430	4	CHBE 440	3
IS 467	3	CHBE 415	3
Language Other Than English (3rd level)	4	IS 477	3
General Education Course (choose a *SBS* course with *CS* designation)	3		
semester sum	17	semester sum	13
Total Hours : _____132_____ (Add up individual semester sums. Must **equal** degree total minimum hours requirement listed on the degree's requirements page in the catalog.)			

Course	Title
Data Science Core	
Mathematical Foundations	
Math 221: Calculus I - First course in calculus and analytic geometry for students with some calculus background; basic techniques of differentiation and integration with applications including curve sketching; antidifferentiation, the Riemann integral, fundamental theorem, exponential and trigonometric functions.	
Math 231: Calculus II - Second course in calculus and analytic geometry: techniques of integration, conic sections, polar coordinates, and infinite series.	
Math 241: Calculus III - Third course in calculus and analytic geometry including vector analysis: Euclidean space, partial differentiation, multiple integrals, line integrals and surface integrals, the integral theorems of vector calculus.	
Math 257: Linear Algebra and Computational Applications - Introductory course incorporating linear algebra concepts with computational tools, with real world applications to science, engineering and data science. Topics include linear equations, matrix operations, vector spaces, linear transformations, eigenvalues, eigenvectors, inner products and norms, orthogonality, linear regression, equilibrium, linear dynamical systems, and the singular value decomposition.	
Math 285: Intro to Differential Equations - Techniques and applications of ordinary differential equations, including Fourier series and boundary value problems, and an introduction to partial differential equations. Intended for engineering majors and others who require a working knowledge of differential equations.	
Data Science Fundamentals	
ChBE 411: Probability and Statistics for Chemical Engineering - Introduction to the foundations of probability and statistics with applications from chemistry, chemical engineering, and biomolecular engineering. Topics include axioms, Bayes' rule, counting techniques, common distributions, expectation values, confidence intervals, hypothesis testing, regression techniques, analysis of variance, error propagation, likelihood maximization, design of experiments, and an introduction to Bayesian statistics	
Stat 207: Data Science Exploration - Explores the data science pipeline from hypothesis formulation, to data collection and management, to analysis and reporting. Topics include data collection, preprocessing and checking for missing data, data summary and visualization, random sampling and probability models, estimating parameters, uncertainty quantification, hypothesis testing, multiple linear and logistic regression modeling, classification, and machine learning approaches for high dimensional data analysis. Students will learn how to implement the methods using Python programming and Git version control.	
CS 307: Modeling and Learning in Data Science - Introduction to the use of classical approaches in data modeling and machine learning in the context of solving data-centric problems. A broad coverage of fundamental models is presented, including linear models, unsupervised learning, supervised learning, and deep learning. A significant emphasis is placed on the application of the models in Python and the interpretability of the results.	

or **ChBE 413: Data Science in Chemistry and Engineering** - Introduction to machine learning and deep learning in the context of chemical sciences. Students gain hands-on experience through in-class exercises and homework using real data sets from chemistry, chemical engineering, biomolecular engineering, and material science. Unique processing and featurization techniques relevant to the chemistry sector are taught. Guest lectures by chemical data scientists from industry and academia offer insight into practical applications and potential career paths. The course concludes with a team-based project on cutting-edge machine learning.

IS 477: Data Management, Curation, and Reproducibility - This course addresses issues in Data Management, Curation & Reproducibility from a Data Science perspective. We discuss definitions of data science, and then introduce and use the Data Science Life Cycle as an intellectual foundation. Topics include Research Artifact Identification and Management, Metadata, Repositories, Economics of Artifact Preservation and Sustainability, and Data Management Plans. We use the case study to ground our discussions in both data sets and in specific data science research. This course requires a final project that applies course knowledge to a data science experiment and creates a data management plan for that experiment.

Computational Fundamentals

CS 101: Intro to Computing for Engineering - Fundamental principles, concepts, and methods of computing, with emphasis on applications in the physical sciences and engineering. Basic problem solving and programming techniques; fundamental algorithms and data structures; use of computers in solving engineering and scientific problems. Intended for engineering and science majors.

CS 277: Algorithms and Data Structures for Data Science - Introduction to elementary concepts in algorithms and classical data structures with a focus on their applications in Data Science. Topics include algorithm analysis (ex: Big-O notation), elementary data structures (ex: lists, stacks, queues, trees, and graphs), basics of discrete algorithm design principles (ex: greedy, divide and conquer, dynamic programming), and discussion of discrete and continuous optimization.

ChBE 412: Computational tools for Chemical Engineering - An introduction to computational tools in Python to solve problems in chemical engineering. Methods for solving nonlinear and differential equations, plotting/animation, optimization, and data modeling are discussed.

Social Impact in Data Science

IS 467: Ethics and Policy for Data Science - The course will address common ethical challenges related to data including privacy, bias, and data access. These challenges will be explored through real-world cases of corporate settings, non-profits, governments, academic research, and healthcare. The course emphasizes the complexity of ethical decision-making and that trade-offs between priorities are often necessary. The course also considers how the burdens of addressing ethical concerns should be distributed among stakeholders. Students will be introduced to a range of relevant policy responses at the organizational, institutional, governmental, and supranational levels.

Course	Title
Coursework in Area of Specialization	
Chemical and Biomolecular Engineering	
ENG 100: Engineering orientation - Introduces students to the Grainger College of Engineering and their respective departments. Students will explore the academic environment at Illinois, developing skills that will aid in learning both inside and outside the classroom, build their leadership and collaborative skills, and build community inside and outside the classroom. Through class discussion and assignments, students will explore campus resources, examine and set goals for academic, personal, and professional development, and develop skills to work in diverse teams through a class project.	
ChBE 121: Chemical and Biomolecular Engineering Profession - Lectures and problems on the history and scope of chemical engineering endeavors; decisions and criteria for process development and plant design.	
ChBE 221: Principles of Chemical Engineering - Lectures and problems on material and energy balances.	
ChBE 321: Thermodynamics - Fundamental concepts and the laws of thermodynamics; the first and second law applications to phase equilibrium and chemical equilibrium and other applications in the Chemical and Biomolecular Engineering profession.	
ChBE 421: Momentum and Heat Transfer - Introduction to fluid statics and dynamics; dimensional analysis; design of flow systems; introduction to heat transfer; conduction, convection, and radiation.	
ChBE 422: Mass Transfer Operations - Introduction to mass transfer processes and design methods for separation equipment.	
ChBE 424: Chemical Reaction Engineering - Chemical kinetics; chemical reactor design; the interrelationship between transport, thermodynamics, and chemical reaction in open and closed systems.	
ChBE 430: Unit Operations Laboratory - Experiments and computation in fluid mechanics, heat transfer, mass transfer, and chemical reaction engineering. Exercises in effective Chemical and Biomolecular Engineering communications.	
ChBE 431: Process Design - Capstone design course where students apply principles from previous courses to the design of complete chemical process systems.	
ChBE 440: Process Control - Techniques used in the analysis of process dynamics and in the design of process control systems.	
Chemistry Fundamentals	
CHEM 102: General Chemistry I - For students who have some prior knowledge of chemistry. Principles governing atomic structure, bonding, states of matter, stoichiometry, and chemical equilibrium.	

CHEM 103: General Chemistry Lab I - Laboratory studies to accompany CHEM 102. Additional fees may apply.

CHEM 104: General Chemistry II - Lecture and discussions. Chemistry of materials, including organic and biological substances, chemical energetics and equilibrium, chemical kinetics, and electrochemistry.

CHEM 105: General Chemistry Lab II - Laboratory studies to accompany CHEM 104.

CHEM 202: Accelerated Chemistry I - Beginning chemistry course for students in the chemical sciences and others with strong high school chemistry and mathematics preparation.

CHEM 203: Accelerated Chemistry Lab I - Companion laboratory course to CHEM 202. Comprehensive skills-oriented approach to learning laboratory technique and safety.

CHEM 204: Accelerated Chemistry II - Continuation of CHEM 202. Lectures and discussions. Emphasizes chemical thermodynamics, equilibrium, chemical kinetics, and coordination chemistry.

CHEM 205: Accelerated Chemistry Lab II - Laboratory and discussion. Includes experiments in qualitative analysis, inorganic synthesis, and kinetics as well as an individual project.

CHEM 222: Quantitative Analysis Lab - Fundamentals of quantitative analysis, chemical equilibrium, and kinetics.

CHEM 223: Quantitative Analysis Lab - Laboratory course covers the fundamentals of quantitative analysis, equilibrium and kinetics.

CHEM 236: Fundamental Organic Chemistry - Fundamental structural, synthetic, and mechanistic organic chemistry is presented. For students whose major is chemistry or for those in the specialized curricula in chemistry or chemical engineering.

CHEM 237: Structure and Synthesis - Laboratory course introduces synthesis and the basic techniques for the separation, isolation, and purification of organic and inorganic compounds.

CHEM 315: Instrumental Chemical Synthesis Lab - Laboratory course emphasizes the application of modern instrumental techniques for characterizing the kinetic behavior and equilibrium properties of chemical systems.

CHEM 420: Instrumental Characterization - Lecture course covers the fundamentals of instrumental characterization including: nuclear magnetic resonance spectroscopy, potentiometry, voltammetry, atomic and molecular spectroscopy, mass spectrometry, and gas and liquid chromatography.

CHEM 442: Physical Chemistry - Lectures and problems focusing on microscopic properties. CHEM 442 and CHEM 444 constitute a year-long study of chemical principles. CHEM 442 focuses on quantum chemistry, atomic and molecular structure, spectroscopy and dynamics.

Physics Fundamentals
Phys 211: Mechanics - Newton's Laws, work and energy, static properties and fluids, oscillations, transverse waves, systems of particles, and rotations. A calculus-based approach for majors in engineering, mathematics, physics and chemistry.
Phys 212: Electricity & Magnetism - Coulomb's Law, electric fields, Gauss' Law, electric potential, capacitance, circuits, magnetic forces and fields, Ampere's law, induction, electromagnetic waves, polarization, and geometrical optics. A calculus-based approach for majors in engineering, mathematics, physics, and chemistry.
Phys 214: Quantum Physics - Interference and diffraction, photons and matter waves, the Bohr atom, uncertainty principle, and wave mechanics. A calculus-based course for majors in engineering, mathematics, physics, and chemistry.

Data Science Experience
ChBE 415: Data science in undergraduate research, internship, or co-op setting - Through internships, research projects, or other off-campus experiences, students will engage in data projects in industry, research, or business settings. Students will gather and analyze data and create comprehensive reports linking their project with data analysis and engineering. Assessments will cover experimental planning, data acquisition, analysis, interpretation, written communication, and presentation

CHBE EQUIPMENT AVAILABLE TO CHBE UG STUDENTS:

Temperature controlled bioreactor/fermenter
Temperature bath and shaker
UV-Vis Spectrophotometer (plate reader)
Ethanol and glucose assay kits
Nikon optical microscope
Refrigerator/freezer
Balances
Centrifuges and supporting equipment such as glassware
Micropipettors
Temperature-zone controlled polymer extruder with annular die and compression rollers
2 precision calipers
2 anemometers.
Temperature controlled jacketed BSTR/CSTR
PFR
Two peristaltic pumps
Conductivity meter/probe
pH meter/probe
Burette
External temperature bath.
Liquid-liquid extraction column
Water pump
Solvent pump
Refractometer for concentration measurement.
1 ½ story five sieve tray glass column
Direct overhead condenser
Thermosyphon Reboiler
Feed tanks
Four pumps
Solenoid valves
Ball valves
PID level control system.
Pignat tray dryer with heater and fan
A balance
3 Liter MDC vacuum chamber
Anprolene AN74i EtO sterilizer
Applied Biosystems 7900HT Fast Real-time PCR machine
BioRad MicroPulser electroporator
Bio-Rad S1000 thermocycler
Branson 2510 sonicator
Brookfield DV-II+ Pro viscometer
Custom-made ultra-high vacuum chambers
Edwards RV12 rotary pump
Eppendorf 5810R benchtop centrifuge
Eppendorf Mastercycler PCR Thermocycler
Fisher Scientific Model 100 Sonic Dismembrator

Florida Object Oriented Process Simulator (FLOOPS)
GE Healthcare AKTA FPLC
GE Typhoon slide scanner
Harvard Apparatus 55-2222 syringe pump
Harvard Scientific dual syringe pumps
Heidolph Hei-VAP rotary evaporator
Jelight Model 20 UV light box
Leica DM IL lED inverted microscope with digital camera
Leica DMI4000B inverted fluorescence microsope
Leica DMIL inverted microscope equipped with a Leica D-LUX 3 CCD camera
Millipore Direct-Q 5 Ultrapure water system
MKS 247 – Mass Flow Controller (MFC) unit
MTS Insight mechanical testing system
Multiple Alcatel Rough vacuum pumps
Napco 8000WJ CO2 incubators
Olympus IX-71 inverted fluorescence microscope
Olympus IX71 outfitted with an Andor Technology Revolution Spinning Disc system
Perkin Elmer Diamond differential scanning calorimeter (DSC)
Physical Electronics Auger/LEED Spectroscopy
TA Instruments SDT Q600 thermogravimetric analyzer (TGA)
Tecan Infinite 200 Pro microplate reader
Tecan M200 microplate reader
Thermo Scientific Max Q4000 Incubator
Thermo Scientific NAPCO series 8000WJ incubator
VirTis Genesis freeze dryer
VWR VistaVision Inverted microscope
Zeiss Axiovert 200M epifluorescence scope
TA Instruments ARES-G2 Strain-controlled Rheometer
TA Instruments DHR-3 Stress-controlled Rheometer
Anton Paar MCR 302 Rheometer
Anton Paar MCR 702 Rheometer
ARE-310 Thinky Mixer (Rogers)
Zeiss LSM710/700 confocal microscopes with spectral deconvolution capacity
Instron 5943 High-accuracy Biomedical test system
Leica DMi8 fluorescence microscope fitted with Yokogawa CSU-W1 widefield spinning disk confocal microscope
Baker Ruskinn InvivO2 400 Hypoxia Workstation
EnvisionTEC 3D-Bioplotter (Harley)
Zeiss LSM 700/880/900 Confocal Microscope (Kong)
Biologic multi-potentiostat with impedance option (VSP-300)
Arbin LBT battery cycler
JEOL Neoscope III benchtop scanning electron microscope with EDS
MBraun inertgas atmosphere glovebox system (Shoetz)

CHBE Undergraduate Research Software:

The list below is a subset of the software available to undergraduates while they are performing research in the labs of our faculty.

Canva
Grammarly
Smug Mug
SnapGene
Amber 22
SLACK
BioRender
Folding@Home
CHEMCAD
CP2K
ORCA
ASE
CHEMKIN
VASP
Chemstation
Minitab
COMSOL
EC-LAB
Gamry EChem Analyst
Gamry Instruments framework
Shimadzu LabSolutions
Edwards nST2 (Vacuum pump control)
PerkinElmer UV WinLab
APT User
Alicat FlowVision 2.0
Origin 2022
Nova 1.11
Nova 2.1
RedySmart
Open lab chemStation
LabView
Matlab

Chemistry Department Equipment

(available for CHBE UG use)

Scale, RADWAG
Electronic Balance, U.S. SOLID
Moveable Airbrush stage, THORLAB LTS150
Hotpress, CARVER 3851-0
Water Purification System E-pure, Barnsteard
GC System, Agilent Model: 8890
Stirring Hot Plate, Corning PC-420D
Electronic Hot PlateANSAI
Ultrasonic Processor, 750 Watts, SONICS CV334
Magnetic Stirrer, IKA
Ultrasonic bath, Bransonic CPXH
Syringe Pump, Harvard Apparatus PHD Ultra
Potentiostat/Galvanostat/ZRA, Gamry 600
Incubator, Incufridge
Scale, OHAUS
Vacuum Oven, INTERTECK BOV-20
Syringe Pump HAVARD apparatus 70-2202
Potentiostat/Galvanostat AUTOLAB PG30
Potentiostat GAMRY
Reference 30K Booster, GAMRY
Peristaltic Pump, MasterFlex L/S
GC System, Agilent Technology
Digital Microscope, Leica, DFC295
Digital Microscope, Leica, MZ125
Digital Microscope, Leica, M205 C
Digital Microscope, LEICA, DM5000 B
Water Deionizer, Barnstead
Vacuum Pump, LabTech, VP18 PLUS
Clinical Centrifuge, INTERNATIONAL EQUIPMENT CO.
UV/VIS Spectrometer, PerkinElmer, Lambda 650
Sonicator, Branson 3510
GC system, thermoscientific Trace 1310
Potentiostat AUTOLAB PGSTAT302N
Water bath JOANLAB W8100-4
CO2 Indicators (2) T and D
O2 sensor (2), MaxTec Handi+
N2 Sensor (2), MaxTec Handi N2
CO2 Indicator 0-100% (2), Forensics Detectors FD-90A
CO2 Indicator 0-10%, Forensics Detectors FD-90A-10
Thermo Scientific Spectrophotometer - Spectronic 200
Thermo Scientific pH Meter - Orion Star A211
Thermo Scientific Spectrophotometers - Genesys 30
Venier LabQuest (pH probes and drop counters)

Nanalysis - NMReady 60 Pro
Thermo Scientific Spectrophotometers - Genesys 30
Venier LabQuest (pH probes and drop counters)
Shimadzu RF-5301 PC Spectrofluorophotometer
Biorad Powerpac HC, Fotodyne FOTO/Phoresis
Waters Acquity Arc LCMS (Sample Manager FTN-R, Quaternary Solvent Manager-R, 2489 UV/Vis Detector, QDa Detector
Bruker EMXPlus Continuous Wave X-band spectrometer
Rigaku Miniflex 600 PXRD instrument
Bruker D8 Venture dual source single crystal diffractometer
Jasco J-1500 CD spectrometer
Leica M205C stereomicroscope
Bruker Daltonics Autoflex Speed LRF MALDI
Bruker Daltonics UltrafleXtreme MALDI TOFTOF
Waters Quattro Ultima ESI
Waters ZMD Quadrupole Instrument
Micromeritics 3Flex and SmartVac
TA Affinity ITC
TA Discovery DSC 250
TA Discovery TGA 5500 with Pfieffer Mass Spec (New but will be installed soon and will be a user run instrument)
Varian 400 MHz for hydrogen and boron NMR
Varian 500 MHz for highly sensitive hydrogen NMR
Varian 500 MHz for hydrogen, carbon, fluorine, and phosphorous NMR
Varian 500 MHz for hydrogen, carbon, fluorine, and phosphorous NMR
Bruker 500 MHz with autosampler for continuous use and Classic CryoProbe for multi-nuclear, very high sensitivity NMR
Bruker 600 MHz with autosampler for continuous use and Prodigy CryoProbe for multi-nuclear, high sensitivity NMR
Varian 600 MHz for multi-nuclear and multi-dimensional NMR
Varian 750 MHz for (typically) peptides and high sensitivity and high resolution hydrogen and carbon NMR
Bruker 500 MHz for solid-state NMR; multi-nuclear with special low-frequency and quadrupole nuclei included
Varian 300 MHz for solid-state NMR; multi-nuclear
BioTek Cytation 5 Imaging reader (includes both)
Thermo Scientific Matrix WellMate
Thermo Scientific Matrix PlateMate plus
Eppendorf Centrifuge 5810R
Eppendorf Centrifuge 5424
LJL Systems Analyst HT (plate reader)
Thermo Scientific ALPS 3000 (Plate sealer)
BioTek ELX405HT2S (plate washer)
Hardinge Lathe, model HLDH
Clausing Cauda Mill, model FV-1
Kalamazoo Band Saw Startrite 3RWS vertical band saw
Autoclaves: 2 x Gettig model 522LS-E autoclaves
Steris model E3033-1 autoclave
Storm 840 imager

Chemistry Department Software

(available for CHBE UG use)

COMSOL, Multiphysics Simulation software
Topspin
Perkin-Elmer Spectrum
Shimadzu LabSolutions RF
Cary Scan, Kinetics)CH Instruments CHI600D potentiometer (CHI 600D Electrochemical Analyzer)
Perkin-Elmer FTIR Spectrum Two
Shimadzu HPLC-UV/Vis (LC-20AT liquid chromatograph, DGU-20A3R degassing unit, SPD-20A UV/Visdetector
LSS Analysis
Cambridge Structure Database software suite
Inorganic Structure Database
Olex2 (single crystal analysis)
ShelXTL (single crystal analysis)
ShelxLE (single crystal analysis)
Platon (diffraction analysis)
Topas v4.2 (pxrd analysis)
Diffrac EVA (pxrd analysis)
NIST11 for GC analysis
MassLynx
TargetLynx
ChromaLynx
Flex Analysis
MNova (for NMR analysis)
Solidworks for design
Molecular Operating Environment (MOE)
Spartan
Schrödinger Suite
Gaussian
GAMESS
Jaguar
NAMD
VMD
ChemDoodle
(Chemdraw is by request and most undergrads can't get this but there are some exceptions)

KEY FACULTY FOR INSTRUCTION IN CHBE COMPONENTS OF DS CORE

Nick Jackson is the Lincoln Excellence for Assistant Professors (LEAP) Scholar in the Department of Chemistry, and an Affiliate Professor in the Department of Chemical and Biomolecular Engineering at the University of Illinois Urbana-Champaign. Professor Jackson obtained his B.A. in Physics from Wesleyan University in 2011, and a Ph.D. in Chemistry from Northewestern University. Prof. Jackson joined the faculty at UIUC in January 2021, following postdoctoral research at the University of Chicago and Argonne National Laboratory. Professor Jackson's research focuses on theoretical and data-driven materials chemistry, including coarse-graining and multiscale simulations, charge transport, and machine learning approaches for soft materials. He has won the Dreyfus Award for Machine Learning in the Chemical Sciences, the ACS PRF Doctoral New Investigator Award, the DOE Early Career Award, and the 3M Nontenured Faculty Award.

ChemE+DS courses: ***ChBE 413***

Mary L. Kraft is the Robert W. Schaefer Scholar, Professor of Chemical and Biomolecular Engineering, and affiliate in the Department of Chemistry at the University of Illinois Urbana-Champaign. She earned a BS in Chemistry from the University of Illinois at Chicago and a PhD in Chemistry from the University of Illinois at Urbana-Champaign. Mary joined the faculty at Illinois in 2007, after postdoctoral research at Stanford University. She develops new bioimaging approaches for individual cells to understand and predict biological function, to detect stem cell differentiation for tissue engineering, and for basic research on plasma membrane organization. She has won the Excellence in Advising Award from the College of Engineering, a Burroughs Wellcome Fund award, the Kirschstein postdoctoral fellowship, a School of Chemical Sciences teaching award, and the American Vacuum Society (AVS) Early Career Award.

ChemE+DS courses: ***ChBE 411***

Ryan G. Mullen is a Specialized Teaching Professor in Chemical and Biomolecular Engineering at the University of Illinois Urbana-Champaign. Ryan earned a B.S. in Chemical Engineering from Brigham Young University and a PhD in Chemical Engineering from the University of California at Santa Barbara. Prior to joining the faculty at Illinois in 2022, Ryan worked as a reservoir engineer for Exxon Mobile, and as a Staff Scientist at the Lawrence Livermore National Laboratory. His courses include process design, cross-curricular design, and computational methods for chemical engineering. Ryan has a strong background in computation including statistical mechanics, artificial intelligence tools for mechanism discovery and hypothesis testing, and advanced sampling methods for molecular simulations. He will take a leading role in administration of the new ChemE+DS program.

ChemE+DS courses: ***ChBE 412****, ChBE 431,* ***ChBE 415***

Baron Peters is the Director of Undergraduate Studies and W. H. and J. G. Lycan Professor in Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign. He completed a B.S. in Chemical Engineering and a B.S. in Mathematics at the University of Missouri – Columbia, and a PhD in Chemical Engineering at the University of California - Berkeley. He did post-doctoral research at the Massachusetts Institute of Technology and at the Centre Europeen de Calcul Atomique et Moleculaire (CECAM) in Lyon, France. He reached the rank of Professor at the University of California – Santa Barbara before moving to the University of Illinois in 2019. Baron has contributed leading methods and theories for understanding the kinetics of crystallization processes, catalysis in disordered materials, and catalysts

for polymer recycling. He also authored "‡" in 2017, the first comprehensive textbook on reaction rate theories and rare event simulation methods. He has won the Camille Dreyfus Teacher-Scholar Award, the NSF Career Award, the CoMSEF Impact Award, and the Separations Division Award for Crystallization at AIChE.

ChemE+DS courses: ***ChBE 411,*** *ChBE 424,* ***ChBE 415***

Christopher Rao

Christopher Rao is the Head and Ray and Beverly Mentzer Professor of Chemical and Biomolecular Engineering. He is also the Deputy Director for the Energy & Biosciences Institute and a member of the Carl R. Woese Institute for Genomic Biology and the Center for Advanced Bioenergy and Bioproducts Innovation. He received his B.S. from Carnegie Mellon University and his Ph.D. from the University of Wisconsin, Madison. Prior to beginning his career at Illinois, he was a postdoctoral fellow at the University of California, Berkeley and the Howard Hughes Medical Institute. Dr. Rao received the National Science Foundation CAREER Award in 2007, the High Impact Paper Award from the International Federation of Automatic Control in 2010, Helen Corley Petit Scholar from the College of Liberal Arts and Sciences in 2011, the Outstanding Young Research Award from the Computing and Systems Technology Division of the American Institute of Chemical Engineers in 2012, the Dean's Award for Excellence in Research from the College of Engineering in 2014, and the Excellence in Teaching Award from the School of Chemical Sciences at Illinois in 2008 and 2023. His research program focuses on 1) discovering how microorganisms sense and respond to their environment and 2) engineering microorganisms to produces fuels and valued-added chemicals from plant biomass.

ChemE+DS courses: ChBE 440, ***ChBE 412***

Diwakar Shuka is a Blue Waters Associate Professor in the Department of Chemical and Biomolecular Engineering and affiliate faculty in the Centers for Biophysics & Quantitative biology and Plant Biology at University of Illinois at Urbana-Champaign. He earned B. Tech and M. Tech degrees in Chemical Engineering at the Indian Institute of Technology (IIT) Bombay, and a PhD in Chemical Engineering from the Massachusetts Institute of Technology. Before joining Illinois, he did postdoctoral research at Stanford University. His research aims to understand complex biological processes using physics-based models, artificial intelligence, and machine learning techniques. In particular, his research group at Illinois is focusing on structural and dynamic understanding of plant proteins. He won the NSF CAREER award, the W. H. Peterson and Open Eye Junior Faculty Awards from the American Chemical Society, the Innovation in Biotechnology Award from the AAPS, the CoMSEF Young Investigator Award, a Sloan Foundation fellowship, a Pivot Fellowship from the Simons Foundation, and a New Innovator award in Food & Agriculture research.

ChemE+DS courses: ***ChBE 413****, ChBE 440*

KEY FACULTY FOR INSTRUCTION IN AREA OF SPECIALIZATION

Ying Diao is an Associate Professor, I. C. Gunsalus Scholar, and Dow Chemical Company Faculty Scholar at University of Illinois at Urbana-Champaign. She received her Ph.D. in Chemical Engineering from MIT in 2012. She started her career in 2015 at Illinois. Her research group focuses on assembly of organic functional materials and innovative printing approaches that enable structural control down to the molecular and nanoscale. Her work has been frequently featured in scientific journals and news media

such as the Science Magazine and Nature Materials. She is named to the MIT Technology Review's annual list of Innovators Under 35 as a pioneer in nanotechnology and materials. She is also a recipient of the NSF CAREER Award, the NASA Early Career Faculty Award, the 3M Non-Tenured Faculty Award, the Van Ness Lectureship, and was recognized by the Sloan Foundation as one of the "very best scientific minds working today".

ChemE+DS courses: ChBE 421

Joachim Floess is a Specialized Teaching Professor in the Department of Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign. He received his bachelors degree at the Rensselaer Polytechnic Institute, and his PhD at the Massachusetts Institute of Technology. His professional experience includes coal gasification research at the General Electric, an academic position with the University of Illinois Chicago (1986-1994), and research on combustion, aerosols, silica aerogel treatment chemistries with Cabot in Tuscola, IL. He joined the faculty at Illinois in 2020, where he teaches process safety, process design, and the unit operations laboratory.

ChemE+DS courses: ChBE 481, ChBE 430, ChBE 431

Damien Guironnet is an Associate Professor in the Department of Chemical and Biomolecular Engineering and in the Department of Chemistry at the University of Illinois Urbana-Champaign. Dr. Guironnet received his MSc from Ecole Nationale Supérieure d'enseignement en Chimie in France in 2005, his PhD from the University of Constance in Germany in 2009, and worked as a postdoctoral associate with Maurice Brookhart at the University of North Carolina. He joined Illinois in 2014 after working as a senior research scientist at BASF Corporation. His research focuses on the development of catalytic polymerization techniques to achieve precise control over polymer composition and architecture. He implement sophisticated reactor engineering strategies to design and automate the synthesis of tailor-made polymers. He has won the Young Investigator Award from the Polymeric Materials division of the American Chemical Society and a School of Chemical Sciences Teaching Award.

ChemE+DS courses: ChBE 422

William S. Hammack

ChemE+DS courses: ChBE 221, ChBE 321

Brendan Harley is the Robert W. Schaefer Professor in Chemical and Biomolecular Engineering, and a research theme leader in the Carl R. Woese Institute for Genomic Biology at the University of Illinois at Urbana-Champaign. He earned an S.B. in Engineering Sciences from Harvard, and an Sc.D. in Mechanical Engineering from the Massachusetts Institute of Technology. Brendan worked as a research fellow at the Children's Hospital in Boston from 2006 to 2008, and then started his career at Illinois. Brendan develops biomaterials that replicate the dynamic, spatially-patterned, and heterogeneous microenvironments found in the tissues and organs of our body. He works to understand how biomaterial cues guide the development, disease progression, and regeneration of cells and tissues. Harley co-authored the book 'Cellular materials in nature and medicine' (Cambridge University Press, 2010) along with 150 peer-reviewed publications. Harley won the NSF CAREER award, the Young Investigator Award from the Society for Biomaterials, and was elected a Fellow of the American Association for the Advancement of Science (2014). He co-founded UK-based Orthomimetics, Ltd.

ChemE+DS courses: ChBE 421

Jonathan Higdon is the Dennis and Cathy Houston Professor of Chemical Engineering at the University of Illinois at Urbana-Champaign. Jon earned a B.E.S degree in Chemical Engineering from Johns Hopkins University, and a PhD in Applied Mathematics and Theoretical Physics from Cambridge University where he was a Winston Churchill Scholar and NSF Fellow. Higdon joined the faculty at Illinois in 1980. His research interests include high performance computation, complex fluids and soft matter, geophysical fluid mechanics, reservoir simulation. He has won the Stanley Corrsin Lectureship in Fluid Dynamics, The Prokasy Award for Undergraduate Teaching at the University of Illinois, and the Presidential Young Investigator Award from the NSF.

ChemE+DS courses: ChBE 221

Paul J.A. Kenis is the Elio E. Tarika Endowed Professor in the Department of Chemical and Biomolecular Engineering and School of Chemical Sciences Director at the University of Illinois Urbana-Champaign. He received his B.S. in Chemistry from Nijmegen Radboud University and his Ph.D. in Chemical Engineering from the University of Twente. He joined the faculty at Illinois in 2004, following postdoctoral research at Harvard University. Professor Kenis' research focuses on microchemical systems with a range of applications including fuel cells, CO2 electrolysis, protein / pharmaceutical crystallization, and cell biology studies. His current research includes automated continuous flow reactors for the synthesis of quantum dots and electrolysis processes for sustainable chemical manufacturing. He has published over 200 peer-reviewed articles, holds 14 patents, and he is an elected fellow of the Electrochemical Society (ECS). His awards include the 3M young faculty award, a NSF CAREER award, a Xerox award, and the ECS Energy Technology Division research award.

ChemE+DS courses: ChBE 121

Hyunjoon Kong is a Robert W Schafer Professor in the Department of Chemical and Biomolecular Engineering. He also is affiliated with the Departments of Bioengineering and a member of the Regenerative Biology & Tissue Engineering research theme at the Carl R. Woese Institute for Genomic Biology. He received his PhD in Chemical Engineering from the University of Michigan and postdoctoral research at Harvard University. Professor Kong joined the Illinois faculty in 2007. His research involves active hybrid materials including stimulus-responsive or self-propelling colloids and hydrogels for thereapeutic applications in vascular and brain diseases. Prof. Kong has authored more than 150 research papers and holds eight patents. He received multiple research awards. He serves on editorial boards for the journals Biomaterials as well as Biofabrication. His awards include the Engineering Dean's Award for Research Achievement, the Campus Distinguished Promotion Award, the Centennial Scholarship, and selection as a Center for Advanced Study Fellow and American Institute for Medical and Biological Engineering (AIMBE) Fellow.

ChemE+DS courses: ChBE 321

Alexa Kuenstler is an Assistant Professor in the Department of Chemical and Biomolecular Engineering at the University of Illinois Urbana-Champaign. She earned a BS in Chemical Engineering from the University of Rochester and a PhD in Polymer Science and Engineering at the University of Massachusetts Amherst. She develops materials capable of on-demand shape changes depending on light-, pH-, and temperature-

conditions. Her thesis work was recognized by the American Physical Society's Division of Polymer Physics as a finalist for the Padden Award.

ChemE+DS courses: ChBE 321

Deborah Leckband is the Reid T. Milner Professor of Chemistry and Professor of Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign. She earned a B.S. in Chemistry from Humboldt State University and a PhD in Biophysical Chemistry from Cornell University. Her research interests focus on the biophysics of cell adhesion, mechanotransduction, and cell mechanics in human disease, tissue morphogenesis, and tissue homeostasis. Her lab uses state-of-the-art imaging techniques, biochemical methods, and mechanical probes to measure forces of protein and cell interactions while imaging the intracellular cascades triggered by cadherin-based mechanotransduction. Deborah won the FIRST Award from the National Institutes of Health, the CAREER Award from the National Science Foundation, the Xerox Award from the College of Engineering, the Amoco Lectureship from Stanford, and the Britton Chance Lectureship from Penn. She an elected fellow in several prestigious professional societies: the Biomedical Engineering Society, the American Chemical Society, the American Association for Advancement of Science, and the American Institute for Medical and Biological Engineering.

ChemE+DS courses: CHEM 315, CHEM 420

Alex Mironenko is an Assistant Professor at the Department of Chemical and Biomolecular Engineering at the University of Illinois, Urbana-Champaign. Before joining the University of Illinois in 2020, he was the Kadanoff-Rice Postdoctoral Fellow in Physical Chemistry at the University of Chicago. Alex Mironenko earned his diploma in Chemical Engineering from Omsk Dostoevsky State University and his Ph.D. in Chemical Engineering from the University of Delaware. His research uses computational heterogeneous catalysis, fundamental quantum mechanics, and molecular simulations to understand the workings of real catalysts for renewable energy applications. He received a number of awards, including the ACS Petroleum Research Fund Doctoral New Investigator Award, the Allan P. Colburn Outstanding Dissertation Prize, the J. William Fulbright Fellowship, the Department of Energy EFRC Achievement Award (2016), the Theodore A. Koch Award from the Catalysis Club of Philadelphia, and Richard J. Kokes Award for the 24th North American Catalysis Society Meeting.

ChemE+DS courses: ChBE 321

Uzoma Monye is a Specialized Teaching Professor in Chemical and Biomolecular Engineering at the University of Illinois Urbana-Champaign. Uzoma earned a B.S. in Chemical Engineering from Columbia University and a PhD in Chemical and Biomolecular Engineering from the University of Pennsylvania. Prior to joining the faculty at Illinois in 2020, Uzoma worked at the American University in Nigeria and did postdoctoral research at North Carolina A&T University. She helped the department navigate the transition to online instruction during the covid pandemic, and she continues to work for improved instruction in several of our laboratory and lecture courses. Her regular teaching assignments include kinetics and reaction engineering, unit operations laboratory, and process design.

ChemE+DS courses: ChBE 430, ChBE 431, ChBE 424

Simon A. Rogers is an Associate Professor in the Department of Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign. He received his BSc in 2001, BSc (Hons) in 2002; and his

PhD from Victoria University of Wellington in New Zealand in 2011. He completed his postdoctoral research at the Foundation for Research and Technology in Crete, the Jülich Research Center in Germany, and the Center for Neutron Research at the University of Delaware. He joined the department in 2015. Dr. Rogers uses experimental and computational tools to understand and model advanced colloidal, polymeric, and self-assembled materials. He has won the NSF CAREER Award, a School of Chemical Sciences Teaching Award, and the A. B. Metzner Award for research in rheology.

ChemE+DS courses: ChBE 221

Teresa Schoetz is an Assistant Professor in Chemical and Biomolecular Engineering at the University of Illinois at Urbana-Champaign. She completed her B.Eng. and M.Sc. degrees in Chemical Engineering and Electrochemistry at the BTU and TU Ilmenau in Germany and a PhD in Electrochemical Engineering at the University of Southampton (UK) in 2019. She did post-doctoral research at the Zepler Institute of the University of Southampton and City College of New York in collaboration with NASA JPL. Theresa has contributed leading electrochemical methods and theories for understanding charge storage mechanisms in batteries and supercapacitors. Theresa also co-authored a book chapter on Electrochemical Charge Storage in the new edition of the Encyclopedia of Electrochemical Power Sources, a standard book in the energy-related and applied electrochemistry community. She was recognized by the Doctoral College Research Award, University of Southampton and LRF Research Award for her work on next-generation energy storage technologies. Theresa currently works on the understanding of molecular-level phenomena that govern macroscopic material properties, charge storage mechanisms, mass transport processes and device performance in batteries beyond lithium-ion.

ChemE+DS courses: ChBE 422

Charles Sing is Professor and Director of Graduate Studies in Chemical and Biomolecular Engineering at the University of Illinois Urbana-Champaign. He earned B.S. and Masters degrees in Polymer Science from Case Western Reserve University, and a PhD in Materials Science from the Massachusetts Institute of Technology. Prior to starting at Illinois in 2014, Sing was a postdoctoral fellow at Northwestern University. His research involves computational and theoretical polymer physics with current projects on polyelectrolyte solutions, out-of-equilibrium rheology of semidilute polymers, polymers with nonlinear architectures, and transport in polymers solutions and networks. He was recognized with an NSF CAREER Award, an Young Investigator Award from the American Chemistry Society Division of Polymeric Materials, a Helen Corley Petit Scholarship from the University of Illinois, and was listed among the American Institute of Chemical Engineers' "35 Under 35."

ChemE+DS courses: ChBE 440

Xiao Su is an Assistant Professor in Chemical and Biomolecular Engineering at the University of Illinois, Urbana-Champaign. He obtained his Bachelor in Applied Sciences in Chemical Engineering from the University of Waterloo in 2011. He completed his PhD in Chemical Engineering from MIT in 2017, during which he was the recipient of the MIT Water Innovation Prize and the MassCEC Catalyst Award for his work on electrochemically-mediated water purification. Since joining Illinois, Xiao has been the recipient of the NSF CAREER Award (2019), the ACS Victor K. Lamer Award (2020), the ISE-Elsevier Prize for Green Electrochemistry (2021), the ACS Unilever Award (2023), and the AIChE FRI/John G. Kunesh Award (2023). His research focuses on molecular engineering for advanced separations and process intensification. His group has pioneered redox-mediated electrochemical separations for a range of applications from water

purification to critical element recovery, pharmaceutical separations, and even downstream biomanufacturing processes.

ChemE+DS courses: ChBE 422

Hong Yang is the Director of Master of Engineering in Chemical Engineering Leadership program and Alkire Chair Professor in Chemical Engineering at the University of Illinois at Urbana-Champaign. He completed a B.S. degree in Chemistry at the Tsinghua University and a PhD in Inorganic Chemistry at the University of Toronto in 1998. He did post-doctoral research at the Harvard University from 1998 and 2001. He then held ranks of Assistant, Associate, and Full Professor at the University of Rochester (2001 – 2011) before moving to the University of Illinois in 2012. Hong has conducted research in the area of nanostructured materials and electrocatalysts for sustainability. He authored about 170 refereed publications and four book chapters. Hong has been an Associate Editor for *Science Advances* - the online extension of Science magazine since 2020 and currently serve as an Editorial Board Member of five others (*Current Opinion in Chemical Engineering, Nano Today, Frontiers in Energy, ChemNanoMat, Energy Material Advances*). Hong has won the NSERC Canada Doctoral Prize (four winners each year) and the NSF Career Award, and is an elected Fellow of AAAS. Hong currently works on the design of electrocatalysts and catalysts to address critical issues for green energy technologies, including hydrogen production, low-temperature fuel cell systems, upgrade of bio-crude oil, and application of rare earth elements in catalysis/electrochemical processes.

ChemE+DS courses: ChBE 221

Huimin Zhao is the Steven L. Miller Chair of chemical and biomolecular engineering at the University of Illinois at Urbana-Champaign (UIUC), director of NSF AI Institute for Molecule Synthesis (moleculemaker.org), and Editor in Chief of ACS Synthetic Biology. He received his B.S. degree in Biology from the University of Science and Technology of China in 1992 and his Ph.D. degree in Chemistry from the California Institute of Technology in 1998 under the guidance of Nobel Laureate Dr. Frances Arnold. Prior to joining UIUC in 2000, he was a project leader at the Industrial Biotechnology Laboratory of the Dow Chemical Company. He was promoted to full professor in 2008. Dr. Zhao has authored and co-authored over 415 research articles and over 30 issued and pending patent applications. In addition, he has given over 470 plenary, keynote, or invited lectures. Thirty-four (34) of his former graduate students and postdocs became professors or principal investigators around the world. Dr. Zhao received numerous research and teaching awards and honors such as AIChE FP&B Division Award, ECI Enzyme Engineering Award, ACS Marvin Johnson Award, and SIMB Charles Thom Award. His primary research interests are in the development and applications of synthetic biology, machine learning, and laboratory automation tools to address society's most daunting challenges in health, energy, and sustainability. Notably, his team recently developed an AI tool named CLEAN to predict enzyme functions from protein sequences and an AI-enabled self-driving biofoundry named BioAutomata for synthetic biology applications.

ChemE+DS courses: ChBE 424

From:	Peters, Baron G
To:	chbe-ugprogramoffice; Amos, Jenny
Cc:	Lehman, Barbara J; Miller, Nolan H; Downie, Stephen R; Rao, Christopher V; Newell, Brooke; chbe-ugprogramoffice; Higdon, Jonathan J L
Subject:	RE: ChemE + DS - STAT response to request for approval of substitutions
Date:	Friday, April 12, 2024 5:32:11 PM
Attachments:	image001.png Letter of Support_ChemE+DS Program_signed tp 08.08.2023.pdf STAT-Support-ChemE+DS Letter.pdf

Dear Professor Amos,

On the ABET questions – you're right that our goal to get ChemE+DS accredited by ABET is unusual. The CS and STAT departments have made clear that they will not provide assessment data for their courses. However, we retained our entire core ChBE sequence in the ChemE+DS degree plan. The only differences between ChBE and ChemE+DS are that

(1) we removed an Organic Chemistry II / Molecular Cell Bio 450 requirement,
(2) all technical electives in the ChBE degree became prescribed data science classes,
(3) we had to add one data science practicum course which took the degree to 132 hours.

In past ABET years, all of our assessment procedures focused on the ChBE core sequence. Because all of the core remains in the ChemE+DS major, and because the degree still satisfies (and far surpasses) their requirements for engineering and science credits, we should be able to also get the new major accredited with no changes in procedure and without relying on assessments from CS, STAT, or other partner departments. There is some debate for us about whether we will even need to treat them as two accreditation efforts or handle ChBE and ChemE+DS accreditation together.

On the STAT and CS approvals, they each have their own process and committees. They all approved the various substitutions that you see. I have attached their final letters here.
I will separately send documentation on long discussions on the omission of STAT 107 and offering an alternative domain-specific option to CS 307 (ChBE 413). Those are several rather long threads with supporting documents. I will try to organize them for you.

Cheers,
Baron Peters

P.S. The X+DS template (at least one of its many iterations) and the STAT 107 course website call this course a recommended intro *for non-technical majors*. I think for most engineering + DS degrees, it will probably make sense to omit STAT 107.

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Sent: Friday, April 12, 2024 3:58 PM

To: Amos, Jenny <jamos@illinois.edu>
Cc: Peters, Baron G <baronp@illinois.edu>; Lehman, Barbara J <bjlehman@illinois.edu>; Miller, Nolan H <nmiller@illinois.edu>; Downie, Stephen R <sdownie@illinois.edu>; Rao, Christopher V <cvrao@illinois.edu>; Newell, Brooke <bsnewell@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: ChemE + DS - STAT response to request for approval of substitutions
Importance: High

Good afternoon, Jenny.

I have reached out to both STAT and CS for written confirmation of their approval of the course substitutions that were approved and completed in the creation of the ChemE + DS Program. We are waiting to hear back from CS, and may already have their approval on file. Until we hear from them, below you'll find Bo Li's approval for the substitutions in question.

Baron Peters is writing up a response to your question about accreditation, and we will also be sending you the information requested (CHBE 411 syllabi, etc.) before your Monday meeting.

Thanks so much,

KATHY THOMAS-STAGG (SHE/HER)
Undergraduate Program Coordinator
Chemical and Biomolecular Engineering
99 Roger Adams Laboratory, M/C 712
600 South Mathews Ave, Urbana, IL 61801
217.333.2888| chbe-ugprogramoffice@illinois.edu

From: Li, Bo libo@illinois.edu
Sent: Friday, April 12, 2024 3:03 PM
To: chbe-ugprogramoffice chbe-ugprogramoffice@illinois.edu; Unger, David dunger@illinois.edu
Cc: Peters, Baron G baronp@illinois.edu; chbe-ugprogramoffice chbe-ugprogramoffice@illinois.edu
Subject: Re: Needing STAT/you're approval immediately

Hi Kathy,

I have approved that in the system, but did not specify that in the letter of support. Yes, after some discussions can receiving clarifications, we approve the substitution of STAT 107 and STAT 400 by your own CHBE course.

Bo

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Date: Friday, April 12, 2024 at 1:52 PM

To: Li, Bo <libo@illinois.edu>, Unger, David <dunger@illinois.edu>
Cc: Peters, Baron G <baronp@illinois.edu>, chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Needing STAT/you're approval immediately

Good afternoon, Dr. Li and Dr. Unger,

Our department has been contacted by Jenny Amos concerning our ChemE+DS program that is going through the approval process. We have a big hurdle to jump on Monday and are needing an immediate response and approval via email from the STAT department showing your approval of our substitution of STAT Courses with our CHBE courses. (Please see the attached email below for further explanation.)

Would you be willing to send me a short email stating your approval of the substitution for the subcommittee on Educational Policy? It would be much appreciated. Thank you for your time and help with this.

Sincerely,
Kathy Thomas-Stag
ChBE Undergraduate Coordinator

-------- Forwarded Message --------
Subject: Proposal to Establish the Bachelor of Science in Chemical Engineering plus Data Science in the College of Liberal Arts and Sciences
Date: Fri, 12 Apr 2024 11:29:57 -0500
From: Amos, Jenny <jamos@illinois.edu>
To: Rao, Christopher V <cvrao@illinois.edu>, Downie, Stephen R <sdownie@illinois.edu>
CC: Miller, Nolan H <nmiller@illinois.edu>, Lehman, Barbara J <bjlehman@illinois.edu>, Newell, Brooke <bsnewell@illinois.edu>

Hi Chris,

I am the subcommittee chair on Educational Policy that has been assigned to your proposal. Although we just received this proposal, we are working diligently to review the proposal. As we reviewed the proposal, the subcommittee had a few questions for which I'd like to get your response.

We understand that this proposal is one of many in the pipeline that is the product of the Spring 2017 Investment for Growth Proposal to "Jump Start Data Science". The proposal aims to Establish the Bachelor of Science in Chemical Engineering plus Data Science in the College of Liberal Arts and Sciences. The proposal, however, deviates from the +DS model in a few ways that you outlined in the proposal. These led to some questions. Please

see below for two main themes of questions.

Questions about Substitutions that seem to go against the +DS core and may affect tuition dollar revenue

1. The CHBE+DS deviates from the standard +DS core by eliminating the basic STAT course STAT 107 and STAT400 and substituting in their own CHBE courses as the STAT. They also allow a substitution of a CHBE course for a CS course. The proposal claims that modifications will be made to CHBE 411, which will be the upper level STAT course. Do you have a revised syllabus or catalog entry for this course?
2. Further, the letter from STAT agrees to accommodate students in their courses but does not comment on the substitution of CHBE courses for their STAT courses. We want to ensure that STAT is aware of and accepts these substitutions specifically.
3. The CS course is substituted with a course called Data Science for Chemical Engineering. Similar to the STAT issue above, CS approves access to the CS courses but did not comment on the substitution of a CS course.

Questions about accreditation

1. Another major change is the number of hours for the degree. The CHBE+DS requires 132 hours to complete. The provided rationale for this is that it will help them meet the ABET accreditation standards.
    1. None of the other +DS or +CS degrees are accredited, so careful attention should be paid to this issue. What is the rationale for seeking accreditation for this degree separate from the CHBE BS degree?
    2. The CHBE standalone degree is 129 hours. A breakdown of how the extra hours are needed to meet the accreditation standards for engineering curricula would be helpful. It will also be helpful to know when will the degrees seek accreditation? i.e. when is the first graduate expected?

Thank you for your

Best,

JENNY AMOS, PH.D. (she/her)
Teaching Professor
Laura Hahn Faculty Scholar
Director, Master of Engineering in Bioengineering
Dean's Fellow, Professional Development

Bioengineering | The Grainger College of Engineering
Biomedical and Translational Sciences | Carle Illinois College of Medicine
Health Sciences Engineering Center | Coordinated Sciences Laboratory
Curriculum & Instruction | College of Education
Industrial Design | School of Art + Design
Center for Global Studies (CGS)

Fellow | Biomedical Engineering Society (BMES)
Fellow | American Institute for Medical and Biological Engineers (AIMBE)

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DEPARTMENT OF COMPUTER SCIENCE
Thomas M. Siebel Center for Computer Science
201 N. Goodwin Ave.
Urbana, IL 61801-2302 USA

NANCY M. AMATO
Abel Bliss Professor and Head
2248 Siebel Center
namato@illinois.edu

August 8, 2023

To Whom It May Concern,

I am writing to indicate the strong support of the Department of Computer Science for the proposal to create a BS in Chemical Engineering + Data Science.

Blended degree programs like this have proven to be extremely popular and given the demand for data science education amongst students, this new degree will meet an urgent need.

The Department of Computer Science agrees to provide seats for students in this program in the following courses:

- CS 101: Intro to Computing for Engineering (Required for ChemE+DS)
- CS 277: Algorithms and Data Structures for Data Science (Required for ChemE+DS)
- CS 307: Modeling and Learning in Data Science (Optional for ChemE+DS)

We intend to offer CS 101 every Fall and Spring semester and CS 277 and CS 307 at least once a year to meet student demand.

Sincerely,

Nancy M. Amato
Abel Bliss Professor and Head
Department of Computer Science

UNIVERSITY OF ILLINOIS
AT URBANA–CHAMPAIGN

Department of Statistics
101 Illini Hall
725 South Wright Street
Champaign, IL 61820

July 25, 2023

To Whom It May Concern,

I am writing to indicate the support of the Department of Statistics for the following proposal:

• ChemE + Data Science

This program will provide students across the university with the opportunity to study data science along with a disciplinary specialization.

The Department of Statistics supports including STAT/CS 207 or STAT 212 in the data science core curriculum. We will provide seats for ChemE + DS students in these courses starting in Fall 2024.

Sincerely,

Bo Li
Professor and Chair
Department of Statistics

telephone 217-333-2167 • *fax* 217-244-7190

From: Peters, Baron G
To: chbe-ugprogramoffice; Amos, Jenny
Cc: Lehman, Barbara J; Miller, Nolan H; Downie, Stephen R; Rao, Christopher V; Newell, Brooke; chbe-ugprogramoffice; Higdon, Jonathan J L; Kraft, Mary L
Subject: RE: Was this the email you needed?
Date: Friday, April 12, 2024 6:06:59 PM
Attachments: image002.png
2024-08-09_RE__ChBE+DS proposalMaheshAndElsaDiscussions.pdf
2023-08-08-FW_RequestsForSTAT107ExceptionCompleted.pdf
ChemE + DS Program Description.docx
Chemical Engineering + Data Science 8-8-23.pdf
2023-08-08-FW__Bo Li"s Response to course approval for +DS.pdf
2023-08-04-RE__Bo Li"s Response to course approval for +DS.pdf
ChBE411-Close-The-Loop.docx
2023-01-15_ChBE 411_Syllabus_rev3_BP.doc

Dear Professor Amos,

I'm having trouble creating a pdf from the thread below, so one of the discussions I promised to share is coming as a forward. The others are attached as pdfs, hopefully they are dated and labeled enough to say what the discussion entails. I have also attached some of the supporting documents.

Please note the "close the loop" discussion which shows internal discussions about the changes we promised to ChBE 411 as part of the negotiations about STAT 107. We did not offer ChBE 411 this spring, but we will implement the promised additions in our ChBE 411 (Probability and Statistics for ChBE) course in the fall.

Cheers,
Baron Peters

From: Amato, Nancy <namato@illinois.edu>
Sent: Tuesday, September 26, 2023 11:46 AM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>; Vera Mikyoung Hur <verahur@math.uiuc.edu>; Li, Bo <libo@illinois.edu>; Blake, Catherine Lesley <clblake@illinois.edu>; head@cs.illinois.edu
Subject: Re: IMPORTANT CHEME+DS course CS info--please read

Hi Baron,

Thanks for this - this looks good and finally we are ready to go with this!

Thank you for your patience with us during this process. I'm now attaching CS's letter of support.

Good luck with this program!

-Nancy

On 9/22/23 10:41 AM, Peters, Baron G wrote:

> Shoot. I forgot the attachment. Here is the course sequence.
>
> -Baron

From: Amato, Nancy <namato@illinois.edu>
Sent: Friday, September 22, 2023 2:12 AM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>; Vera Mikyoung Hur <verahur@math.uiuc.edu>; Li, Bo <libo@illinois.edu>; Blake, Catherine Lesley <clblake@illinois.edu>
Subject: Re: IMPORTANT CHEME+DS course CS info--please read

Hi Baron,

Thanks for working with us on this.

Our informal X+DS coordinating committee for the X+DS programs met yesterday. In addition to discussing how we can act in a more coordinated fashion going forward we discussed your proposal.

Briefly, we agree ChemE+DS is a strong proposal which will be a great addition to the X+DS offerings and think we're almost there.

In CS, we reviewed the proposal for ChBE 413 and think it is a good course that would be an appropriate substitute for CS 307. So that is fine.

We have just one last question for you. STAT/CS/IS 107 is a pre-req for STAT 207. So, since the ChemE+DS students will take ChBE411 and CS101 instead of STAT/CS/IS 107, they would need to have taken both courses before they take STAT 207 (and we'll need to update the pre-reqs for STAT 207 accordingly). We just wanted to confirm that that will be possible for your students and not impact their ability to complete the major. So long as that is the case, we can move forward on this.

Thanks again for your patience,

-Nancy

On behalf of the informal X+DS Coordination Committee: Nancy Amato (CS), Cathy Blake (iSchool), Vera Hur (Math), Bo Li (Statistics)

On 9/14/23 5:44 PM, Peters, Baron G wrote:

> Dear Professor Amato,
>
> Thank you so much for the fast and professional reply. And my apologies for letting my frustration show in the earlier message.
>
> Please find attached the course syllabus and course proposal for ChBE 413: Data Science in Chemistry and Engineering.
>
> I also understand that Matt Ando was the champion of these X+DS proposals. We tried to finish everything before he left, but the new CIM-P system was not something I saw coming. Anyway, his X+DS initiative is still a great idea. We think it will be a particularly innovative and popular attraction for ChBE at Illinois.
>
> Sincerely,

Baron Peters

From: Amato, Nancy <namato@illinois.edu>
Sent: Thursday, September 14, 2023 2:04 PM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>
Subject: Re: IMPORTANT CHEME+DS course CS info--please read

Hi Baron,

First, let me apologize and 100% agree with you. We have absolutely not be coordinating among the X+DS core providers as we should have, and in the case of your particular degree proposal, I'd like to personally apologize for not being on top of things better. Matt Ando had been operating at the leader of our group, and with his departure over the summer we have not put in place a good alternative structure and as a result we have not been coordinating amongst ourselves before communicating with you. We have a meeting set up for next Wednesday where we will discuss this issue and I am hopeful future X+DS degree proposers will not face the issues that you have.

Related to your ChemE+DS degree, we are truly excited to help you get this through, but we also want to be sure the degree work work for the students and achieve all the learning objectives we have for them.

Now let me apologize again, but I'd like to ask you for some additional information about CheBE 413 that we should have requested before. We have seen a brief description and it sounds like an excellent course, but we'd appreciate if you could share the syllabus with us. This will help us to better evaluate if it could be an appropriate substitute for CS 307.

Again, let me apologize and ask your understanding as we work though this - we are committed to making this process work better for everyone.

-Nancy

On 9/14/23 2:40 AM, Peters, Baron G wrote:

> Dear Professors Gunter, Amato,
>
> CS seems to have me in an infinite loop I know that email threads are tedious, but I hope you can help us escape the loop this time.
>
> We had these discussions with Jeff Douglas, then Mahesh Viswanathan, then Bo Li (from Statistics and CS). Each representative of the committee raises similar concerns. Each decides that we can go forward after adding some language to the proposal. We add the requested text and send it back. And then, instead of gaining approval, a new person in CS answers and starts the discussion again.
>
> Forgive me, but I have to ask … is this group really acting as a committee? I understand that people rotate in and out, but there seems to be no continuity of knowledge about its past decisions. In brief, I will summarize the previous discussions here.
>
> 1. Regarding pre-reqs for STAT 207, the course syllabus (online) says: "Students who completed STAT 100 or 107 previously are welcome. Equally welcome are students in quantitative fields taking STAT 200 [sic] as their first course in statistical analysis." ChBE is a quantitative major with the same early curriculum as the rest of engineering (ENG 100, CS 101, PHYS 200's, CHEM 200's, etc.) Also, Professor Bo Li already considered the pre-reqs in statistics courses. She approved inclusion of STAT 207 (without 107) on behalf of Statistics. I'm happy to send that correspondence if needed.
> 2. In LAS, new majors and new courses for those majors can be proposed concurrently. Both new courses, ChBE 413 and ChBE 415, have been entered in the CIM system, and both are pending approval now.
> 3. Regarding CS 307 vs. ChBE 413: We will not offer ChBE 413 more than once per year. Therefore, many ChemE+DS students will take CS 307, likely more than half. So why include ChBE 413? We want the ChemE+DS curriculum to seamlessly integrate data science with ChBE domain expertise. Throughout the proposal, you will see an emphasis on data science instruction within the context of chemical engineering. In particular, please note the language that we added, at the request of your department, in the Program Description section (and attachments) of the proposal. In short, we believe it is the integration of data science instruction with ChBE domain expertise that will make ChemE+DS something better than a B.S. in ChBE with a disjoint Data Science minor.
> 4. Computer Scientists (especially those at U of Illinois) can run circles around engineers who often approach data science as dabblers and bandwagoners. However, the course in question (ChBE 413) will be taught by Professors Nick Jackson and Diwakar Shukla. Both have won prestigious national awards (NSF CAREER, Sloan, CoMSEF, etc.) for their research on data science in the context of chemistry and chemical engineering. It is hard to imagine better instructors for an integrated data science in chemical engineering course.
>
> ChBE is most nervously waiting on permission from CS to include CS 101, CS 277, and CS 307 in the proposal. That deadline is days away – maybe not even two full days now. The courses in question are just the CS courses in the standard X+DS template. Therefore, this course approval step should be easy.
>
> On the more difficult issue of overall ChemE+DS approval, I am happy to visit Computer Science in person if that helps. In the meantime, Kathy Thomas (our Undergraduate Program Coordinator) will send the proposal with highlights on the previously requested additions that I described in (3). If you would like, we can also organize and assemble the previous correspondences with all parties. …that will be a thick binder, but we're willing to do whatever is needed.
>
> ChemE+DS will be a great program, for ChBE, for COE, and for our students, but it's not going to happen without official approval from Computer Science. I really hope you can look at the past discussions (feel free to share this and discuss with the others) to see that we've already converged on these issues a few times. Thank you for understanding my urgent plea on this.
>
> Sincerely,
>
> Baron Peters
> W. H. and J. G. Lycan Professor
> Director of Undergraduate Studies
> Chemical and Biomolecular Engineering
> University of Illinois at Urbana-Champaign
> https://petersgroup.web.illinois.edu/
> baronp@illinois.edu
> 805-284-8293

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Sent: Wednesday, September 13, 2023 3:14 PM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Higdon, Jonathan J L <jhigdon@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: IMPORTANT CHEME+DS course CS info--please read

Please read the email chain below, and we can discuss tomorrow morning with Jon, if you'd like.

Thanks so much,

KATHY THOMAS-STAGG *(SHE/HER)*
Undergraduate Program Coordinator

Chemical and Biomolecular Engineering
99 Roger Adams Laboratory, M/C 712
600 South Mathews Ave, Urbana, IL 61801
217.333.2888| klt7@illinois.edu

From: Gunter, Elsa <egunter@illinois.edu>
Sent: Wednesday, September 13, 2023 2:06 PM
To: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Cc: Herzog, Stephen M <smherzog@illinois.edu>; Newell, Brooke <bsnewell@illinois.edu>; Amato, Nancy <namato@illinois.edu>
Subject: Re: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program

Dear Katie,

I can not speak to the procedural matters for resolving this situation, but I can speak to the perceived difficulties. Since you seem to be asking for specific details, the concerns are on the one hand about prerequisite satisfaction for STAT 207, and through that for CS 277 and CS 307, and on the other, the fact that you are making CS 307 optional with a possible substitution of a class that has not yet been approved as a class, let alone vetted as an appropriate substitution for CS 307. I don't think there is much more I can say about the second issue.

For the first, I have asked David Unger in Statistic whether Statistics has given approval for CS 101 to be an alternate prerequisite for STAT 207. His reply was that the matter had not been put to the Statistics Courses and Curriculum committee, and he asked me for details of CS 101, which I promptly supplied him. I believe that topic is on the C&C committee's agenda. CS 101 is a significantly more thorough introduction to programming than STAT 107. STAT 107 is primarily a statistics course, but the python programming it does teach is focused on statistics applications. CS 101 is focused on calculus and scientific computing applications and does not cover the data packages that STAT 207, CS 277 and CS 307 reply upon as prerequisite knowledge. If Statistics allows CS 101 as a substitution for the prerequisites for STAT 207, then we would like to see at least an assurance from Statistics that STAT 207 will assume the responsibility for providing the needed statistics-orient programming expected from STAT 107. A course revision would be more reassuring.

The decision about whether the substitution of ChBE 413 for CS 307 is acceptable at the level of the program is a matter for the informal X+DS coordination committee, as is the substitution of CS 101 for STAT 107. At the level of courses, I am concerned that we understand how the prerequisites for the CS courses will be satisfied. I am waiting to hear from Statistics for a clarification of that.

---Elsa

On 9/12/23 4:53 PM, Herzog, Stephen M wrote:

> Hi Kathy,
>
> I'm sorry for the delay – we've had transition of associate heads so it wasn't clear in my mind who should even reply to you. I think Elsa Gunter, who now has the job, is the person to reply (though I think she had some questions, too).
>
> Steve
>
> **Steve Herzog** (he/him/his)
> Assistant Director of Undergraduate Programs
> Department of Computer Science
> University of Illinois at Urbana-Champaign
> smherzog@illinois.edu
>
> 1210 Siebel Center for Computer Science
>
> ---
>
> **From:** chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
> **Sent:** Tuesday, September 12, 2023 2:45 PM
> **To:** Herzog, Stephen M <smherzog@illinois.edu>
> **Cc:** chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
> **Subject:** FW: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program
> **Importance:** High
>
> Hi there, Steve.
>
> Brooke suggested I touch base with you with the most recent correspondence that I've had with CS about them approving the 3 courses we need them to approve for the ChemE + DS program submission. (Please see below.) I'm confused by a couple of things that Dr. Amato shared as roadblocks to the approval we are seeking. One is her comment about our proposal not following the recommended template (I am currently inputting all of the required info into the CIM-P portal, so I'm not quite sure what she's referencing and didn't know if you might be able to shed some light on it.). Also, she commented on conferring with her colleagues in STAT, MATH, IS, and CS. STAT, MATH, and IS have already approved the new program and given us the course approval for the courses we'd like to use for the ChemE+DS program that is from their departments. Do you have any thoughts on what I can do to assist in this process so it doesn't get hung up anymore? The 3-course approval is the only thing I need to properly submit our ChemE+DS program. Thank you for any insight or suggestions you may have—I appreciate your expertise!
>
> Thanks so much,
>
> **KATHY THOMAS-STAGG** *(SHE/HER)*
> *Undergraduate Program Coordinator*
>
> Chemical and Biomolecular Engineering
> 99 Roger Adams Laboratory, M/C 712
> 600 South Mathews Ave, Urbana, IL 61801
> 217.333.2888| klt7@illinois.edu

From: Amato, Nancy <namato@illinois.edu>
Sent: Thursday, September 7, 2023 10:25 AM
To: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Cc: Viswanathan, Mahesh <vmahesh@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Fleck, Margaret M <mfleck@illinois.edu>; Peters, Baron G <baronp@illinois.edu>; Rao, Christopher V <cvrao@illinois.edu>; ChBE Director of Undergraduate Studies <chbe-dus@illinois.edu>
Subject: Re: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program

Thanks Kathy - as I mentioned to Baron, we are working through our own internal coordination kinks and will do our best to get back to you asap.

-nancy

On 9/7/23 10:20 AM, chbe-ugprogramoffice wrote:

> Good morning, Nancy.
>
> Thank you for your quick response—I know how busy this time of year can be. I am working with Dr. Peters on the ChemE + DS program proposal, inputting the information, and acquiring the course and program approval letters for the proposal submission. I have already received letters from Statistics, Math, and iSchool in support of the ChemE+DS program using courses from their departments along with approval for our new program (please see attached).
>
> Understandably, there might be some confusion about the template, as the university has changed the program and course proposal templates since we first started this process last year. Since then, I have updated the proposal and am now using the template that is the one the university uses and requires for all of the program proposals, via the CIM portal. (Please see the attached and most current version of our +DS program proposal, as it is not the same format/template as the one you first received earlier this summer.) Can you please clarify what the recommended template is that you're referring to? Thank you for clarifying. CS is the last department we need course approval from in order to submit our +DS proposal, so I'm hopeful we can get these courses approved and any questions answered in time to meet the next deadline here in the next week or two. Thank you for your time and expertise.
>
> Thanks so much,
>
> **KATHY THOMAS-STAGG** *(SHE/HER)*
> *Undergraduate Program Coordinator*
>
> Chemical and Biomolecular Engineering
> 99 Roger Adams Laboratory, M/C 712
> 600 South Mathews Ave, Urbana, IL 61801
> 217.333.2888| klt7@illinois.edu

From: Amato, Nancy <namato@illinois.edu>
Sent: Thursday, September 7, 2023 9:21 AM
To: ChBE Director of Undergraduate Studies <chbe-dus@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Fleck, Margaret M <mfleck@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Peters, Baron G <baronp@illinois.edu>; Rao, Christopher V <cvrao@illinois.edu>
Subject: Re: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program

Hi Baron,

Thanks again for your interest in developing a ChemE + DS degree! We are excited to work with you on this.

Since this proposal doesn't follow the recommended template, we will need to discuss with our informal X+DS coordination committee that includes representatives from the four units providing the core (Statistics, Math, iSchool and CS).

I'll reach out to them and we'll try to get back to you soon.

-Nancy

On 9/6/23 11:38 AM, ChBE Director of Undergraduate Studies wrote:

ILLINOIS

COLLEGE OF LIBERAL ARTS & SCIENCES
Department of Chemical & Biomolecular Engineering
114 Roger Adams Laboratory, MC-712
600 S. Mathews Ave.
Urbana, IL 61801

September 6, 2023

Dear Professor Amato, Professor Viswanathan, Professor Gunter, and Professor Fleck:

I am writing to ask for your endorsement and future cooperation on a new ChemE+DS program. ***A draft proposal for the ChemE+DS program is attached to this message***. The new program will require ChBE students to take some courses in your department. We anticipate approximately 10-40 students per year will enroll in the ChemE+DS program. These students should be allowed, and in some cases will be required, to take the following courses from your department:

CS 101: Intro to Computing for Engineering (Required for ChemE+DS)
CS 277: Algorithms and Data Structures for Data Science (Required for ChemE+DS)
CS 307: Modeling and Learning in Data Science (Optional for ChemE+DS)

With approval from your department, we would like to begin to have students taking these courses in pursuit of ChemE+DS degrees as early as Spring 2024. We have attached a copy of the proposal for this new degree program for your consideration. If you approve, please reply with an official statement of approval and cooperation.

Regards,

Baron Peters
William H. and Janet G. Lycan Professor
and Director of Undergraduate Studies
292 Roger Adams Laboratory
baronp@illinois.edu

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++
Nancy M. Amato
Abel Bliss Professor and Head, Department of Computer Science
University of Illinois at Urbana-Champaign
2232 Siebel Center, 201 N. Goodwin Ave., Urbana IL 61801
+1-217-333-3426, namato@illinois.edu
head@cs.illinois.edu (for scheduling or administrative contact)
++

PS. We have some great postdoc openings: the department's Future Faculty
Fellows program (https://go.cs.illinois.edu/fff)

PPS. Check out iCAN (Illinois Computing Accelerator for Non-Specialists),
a 1-year program for non-computing college graduates. A bridge to a career
in tech or grad studies. Applications for our 4th cohort are open now!
http://cs.illinois.edu/ican

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Nancy M. Amato
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2232 Siebel Center, 201 N. Goodwin Ave., Urbana IL 61801
+1-217-333-3426, namato@illinois.edu
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http://cs.illinois.edu/ican

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Elsa L Gunter
Research Professor
Associate Head for Academics
Department of Computer Science
University of Illinois at Urbana - Champaign

--

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Nancy M. Amato
Abel Bliss Professor and Head, Department of Computer Science
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+1-217-333-3426, namato@illinois.edu
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Nancy M. Amato
Abel Bliss Professor and Head, Department of Computer Science
University of Illinois at Urbana-Champaign
2232 Siebel Center, 201 N. Goodwin Ave., Urbana IL 61801
+1-217-333-3426, namato@illinois.edu
head@cs.illinois.edu (for scheduling or administrative contact)
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in tech or grad studies. Applications for our 4th cohort are open now!
http://cs.illinois.edu/ican

From:	Peters, Baron G
To:	chbe-ugprogramoffice; Amos, Jenny
Cc:	Lehman, Barbara J; Miller, Nolan H; Downie, Stephen R; Rao, Christopher V; Newell, Brooke; chbe-ugprogramoffice; Higdon, Jonathan J L
Subject:	RE: ChemE + DS - STAT response to request for approval of substitutions
Date:	Friday, April 12, 2024 5:32:11 PM
Attachments:	image001.png Letter of Support_ChemE+DS Program_signed tp 08.08.2023.pdf STAT-Support-ChemE+DS Letter.pdf

Dear Professor Amos,

On the ABET questions – you're right that our goal to get ChemE+DS accredited by ABET is unusual. The CS and STAT departments have made clear that they will not provide assessment data for their courses. However, we retained our entire core ChBE sequence in the ChemE+DS degree plan. The only differences between ChBE and ChemE+DS are that

(1) we removed an Organic Chemistry II / Molecular Cell Bio 450 requirement,
(2) all technical electives in the ChBE degree became prescribed data science classes,
(3) we had to add one data science practicum course which took the degree to 132 hours.

In past ABET years, all of our assessment procedures focused on the ChBE core sequence. Because all of the core remains in the ChemE+DS major, and because the degree still satisfies (and far surpasses) their requirements for engineering and science credits, we should be able to also get the new major accredited with no changes in procedure and without relying on assessments from CS, STAT, or other partner departments. There is some debate for us about whether we will even need to treat them as two accreditation efforts or handle ChBE and ChemE+DS accreditation together.

On the STAT and CS approvals, they each have their own process and committees. They all approved the various substitutions that you see. I have attached their final letters here.
I will separately send documentation on long discussions on the omission of STAT 107 and offering an alternative domain-specific option to CS 307 (ChBE 413). Those are several rather long threads with supporting documents. I will try to organize them for you.

Cheers,
Baron Peters

P.S. The X+DS template (at least one of its many iterations) and the STAT 107 course website call this course a recommended intro *for non-technical majors*. I think for most engineering + DS degrees, it will probably make sense to omit STAT 107.

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Sent: Friday, April 12, 2024 3:58 PM

To: Amos, Jenny <jamos@illinois.edu>
Cc: Peters, Baron G <baronp@illinois.edu>; Lehman, Barbara J <bjlehman@illinois.edu>; Miller, Nolan H <nmiller@illinois.edu>; Downie, Stephen R <sdownie@illinois.edu>; Rao, Christopher V <cvrao@illinois.edu>; Newell, Brooke <bsnewell@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: ChemE + DS - STAT response to request for approval of substitutions
Importance: High

Good afternoon, Jenny.

I have reached out to both STAT and CS for written confirmation of their approval of the course substitutions that were approved and completed in the creation of the ChemE + DS Program. We are waiting to hear back from CS, and may already have their approval on file. Until we hear from them, below you'll find Bo Li's approval for the substitutions in question.

Baron Peters is writing up a response to your question about accreditation, and we will also be sending you the information requested (CHBE 411 syllabi, etc.) before your Monday meeting.

Thanks so much,

KATHY THOMAS-STAGG (SHE/HER)
Undergraduate Program Coordinator
Chemical and Biomolecular Engineering
99 Roger Adams Laboratory, M/C 712
600 South Mathews Ave, Urbana, IL 61801
217.333.2888| chbe-ugprogramoffice@illinois.edu

From: Li, Bo libo@illinois.edu
Sent: Friday, April 12, 2024 3:03 PM
To: chbe-ugprogramoffice chbe-ugprogramoffice@illinois.edu; Unger, David dunger@illinois.edu
Cc: Peters, Baron G baronp@illinois.edu; chbe-ugprogramoffice chbe-ugprogramoffice@illinois.edu
Subject: Re: Needing STAT/you're approval immediately

Hi Kathy,

I have approved that in the system, but did not specify that in the letter of support. Yes, after some discussions can receiving clarifications, we approve the substitution of STAT 107 and STAT 400 by your own CHBE course.

Bo

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Date: Friday, April 12, 2024 at 1:52 PM

To: Li, Bo <libo@illinois.edu>, Unger, David <dunger@illinois.edu>
Cc: Peters, Baron G <baronp@illinois.edu>, chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Needing STAT/you're approval immediately

Good afternoon, Dr. Li and Dr. Unger,

Our department has been contacted by Jenny Amos concerning our ChemE+DS program that is going through the approval process. We have a big hurdle to jump on Monday and are needing an immediate response and approval via email from the STAT department showing your approval of our substitution of STAT Courses with our CHBE courses. (Please see the attached email below for further explanation.)

Would you be willing to send me a short email stating your approval of the substitution for the subcommittee on Educational Policy? It would be much appreciated. Thank you for your time and help with this.

Sincerely,
Kathy Thomas-Stag
ChBE Undergraduate Coordinator

-------- Forwarded Message --------
Subject: Proposal to Establish the Bachelor of Science in Chemical Engineering plus Data Science in the College of Liberal Arts and Sciences
Date: Fri, 12 Apr 2024 11:29:57 -0500
From: Amos, Jenny <jamos@illinois.edu>
To: Rao, Christopher V <cvrao@illinois.edu>, Downie, Stephen R <sdownie@illinois.edu>
CC: Miller, Nolan H <nmiller@illinois.edu>, Lehman, Barbara J <bjlehman@illinois.edu>, Newell, Brooke <bsnewell@illinois.edu>

Hi Chris,

I am the subcommittee chair on Educational Policy that has been assigned to your proposal. Although we just received this proposal, we are working diligently to review the proposal. As we reviewed the proposal, the subcommittee had a few questions for which I'd like to get your response.

We understand that this proposal is one of many in the pipeline that is the product of the Spring 2017 Investment for Growth Proposal to "Jump Start Data Science". The proposal aims to Establish the Bachelor of Science in Chemical Engineering plus Data Science in the College of Liberal Arts and Sciences. The proposal, however, deviates from the +DS model in a few ways that you outlined in the proposal. These led to some questions. Please

see below for two main themes of questions.

Questions about Substitutions that seem to go against the +DS core and may affect tuition dollar revenue

1. The CHBE+DS deviates from the standard +DS core by eliminating the basic STAT course STAT 107 and STAT400 and substituting in their own CHBE courses as the STAT. They also allow a substitution of a CHBE course for a CS course. The proposal claims that modifications will be made to CHBE 411, which will be the upper level STAT course. Do you have a revised syllabus or catalog entry for this course?
2. Further, the letter from STAT agrees to accommodate students in their courses but does not comment on the substitution of CHBE courses for their STAT courses. We want to ensure that STAT is aware of and accepts these substitutions specifically.
3. The CS course is substituted with a course called Data Science for Chemical Engineering. Similar to the STAT issue above, CS approves access to the CS courses but did not comment on the substitution of a CS course.

Questions about accreditation

1. Another major change is the number of hours for the degree. The CHBE+DS requires 132 hours to complete. The provided rationale for this is that it will help them meet the ABET accreditation standards.
    1. None of the other +DS or +CS degrees are accredited, so careful attention should be paid to this issue. What is the rationale for seeking accreditation for this degree separate from the CHBE BS degree?
    2. The CHBE standalone degree is 129 hours. A breakdown of how the extra hours are needed to meet the accreditation standards for engineering curricula would be helpful. It will also be helpful to know when will the degrees seek accreditation? i.e. when is the first graduate expected?

Thank you for your

Best,

JENNY AMOS, PH.D. (she/her)
Teaching Professor
Laura Hahn Faculty Scholar
Director, Master of Engineering in Bioengineering
Dean's Fellow, Professional Development

Bioengineering | The Grainger College of Engineering
Biomedical and Translational Sciences | Carle Illinois College of Medicine
Health Sciences Engineering Center | Coordinated Sciences Laboratory
Curriculum & Instruction | College of Education
Industrial Design | School of Art + Design
Center for Global Studies (CGS)

Fellow | Biomedical Engineering Society (BMES)
Fellow | American Institute for Medical and Biological Engineers (AIMBE)

3242 Everitt Lab
1406 W. Green | MC 278

Urbana, IL 61801
217.333.4212 | jamos@illinois.edu
LinkedIn | @jennyamos_uiuc
publish.illinois.edu/jennyamoslab/
https://bioengineering.illinois.edu/

ILLINOIS

ILLINOIS

DEPARTMENT OF COMPUTER SCIENCE
Thomas M. Siebel Center for Computer Science
201 N. Goodwin Ave.
Urbana, IL 61801-2302 USA

NANCY M. AMATO
Abel Bliss Professor and Head
2248 Siebel Center
namato@illinois.edu

August 8, 2023

To Whom It May Concern,

I am writing to indicate the strong support of the Department of Computer Science for the proposal to create a BS in Chemical Engineering + Data Science.

Blended degree programs like this have proven to be extremely popular and given the demand for data science education amongst students, this new degree will meet an urgent need.

The Department of Computer Science agrees to provide seats for students in this program in the following courses:

- CS 101: Intro to Computing for Engineering (Required for ChemE+DS)
- CS 277: Algorithms and Data Structures for Data Science (Required for ChemE+DS)
- CS 307: Modeling and Learning in Data Science (Optional for ChemE+DS)

We intend to offer CS 101 every Fall and Spring semester and CS 277 and CS 307 at least once a year to meet student demand.

Sincerely,

Nancy M. Amato
Abel Bliss Professor and Head
Department of Computer Science

UNIVERSITY OF ILLINOIS
AT URBANA–CHAMPAIGN

Department of Statistics
101 Illini Hall
725 South Wright Street
Champaign, IL 61820

July 25, 2023

To Whom It May Concern,

I am writing to indicate the support of the Department of Statistics for the following proposal:

• ChemE + Data Science

This program will provide students across the university with the opportunity to study data science along with a disciplinary specialization.

The Department of Statistics supports including STAT/CS 207 or STAT 212 in the data science core curriculum. We will provide seats for ChemE + DS students in these courses starting in Fall 2024.

Sincerely,

Bo Li
Professor and Chair
Department of Statistics

telephone 217-333-2167 • *fax* 217-244-7190

From: Peters, Baron G
To: chbe-ugprogramoffice; Amos, Jenny
Cc: Lehman, Barbara J; Miller, Nolan H; Downie, Stephen R; Rao, Christopher V; Newell, Brooke; chbe-ugprogramoffice; Higdon, Jonathan J L; Kraft, Mary L
Subject: RE: Was this the email you needed?
Date: Friday, April 12, 2024 6:06:59 PM
Attachments: image002.png
2024-08-09_RE__ChBE+DS proposalMaheshAndElsaDiscussions.pdf
2023-08-08-FW_RequestsForSTAT107ExceptionCompleted.pdf
ChemE + DS Program Description.docx
Chemical Engineering + Data Science 8-8-23.pdf
2023-08-08-FW__Bo Li"s Response to course approval for +DS.pdf
2023-08-04-RE__Bo Li"s Response to course approval for +DS.pdf
ChBE411-Close-The-Loop.docx
2023-01-15_ChBE 411_Syllabus_rev3_BP.doc

Dear Professor Amos,

I'm having trouble creating a pdf from the thread below, so one of the discussions I promised to share is coming as a forward. The others are attached as pdfs, hopefully they are dated and labeled enough to say what the discussion entails. I have also attached some of the supporting documents.

Please note the "close the loop" discussion which shows internal discussions about the changes we promised to ChBE 411 as part of the negotiations about STAT 107. We did not offer ChBE 411 this spring, but we will implement the promised additions in our ChBE 411 (Probability and Statistics for ChBE) course in the fall.

Cheers,
Baron Peters

From: Amato, Nancy <namato@illinois.edu>
Sent: Tuesday, September 26, 2023 11:46 AM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>; Vera Mikyoung Hur <verahur@math.uiuc.edu>; Li, Bo <libo@illinois.edu>; Blake, Catherine Lesley <clblake@illinois.edu>; head@cs.illinois.edu
Subject: Re: IMPORTANT CHEME+DS course CS info--please read

Hi Baron,

Thanks for this - this looks good and finally we are ready to go with this!

Thank you for your patience with us during this process. I'm now attaching CS's letter of support.

Good luck with this program!

-Nancy

On 9/22/23 10:41 AM, Peters, Baron G wrote:

> Shoot. I forgot the attachment. Here is the course sequence.
>
> -Baron

From: Amato, Nancy <namato@illinois.edu>
Sent: Friday, September 22, 2023 2:12 AM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>; Vera Mikyoung Hur <verahur@math.uiuc.edu>; Li, Bo <libo@illinois.edu>; Blake, Catherine Lesley <clblake@illinois.edu>
Subject: Re: IMPORTANT CHEME+DS course CS info--please read

Hi Baron,

Thanks for working with us on this.

Our informal X+DS coordinating committee for the X+DS programs met yesterday. In addition to discussing how we can act in a more coordinated fashion going forward we discussed your proposal.

Briefly, we agree ChemE+DS is a strong proposal which will be a great addition to the X+DS offerings and think we're almost there.

In CS, we reviewed the proposal for ChBE 413 and think it is a good course that would be an appropriate substitute for CS 307. So that is fine.

We have just one last question for you. STAT/CS/IS 107 is a pre-req for STAT 207. So, since the ChemE+DS students will take ChBE411 and CS101 instead of STAT/CS/IS 107, they would need to have taken both courses before they take STAT 207 (and we'll need to update the pre-reqs for STAT 207 accordingly). We just wanted to confirm that that will be possible for your students and not impact their ability to complete the major. So long as that is the case, we can move forward on this.

Thanks again for your patience,

-Nancy

On behalf of the informal X+DS Coordination Committee: Nancy Amato (CS), Cathy Blake (iSchool), Vera Hur (Math), Bo Li (Statistics)

On 9/14/23 5:44 PM, Peters, Baron G wrote:

> Dear Professor Amato,
>
> Thank you so much for the fast and professional reply. And my apologies for letting my frustration show in the earlier message.
>
> Please find attached the course syllabus and course proposal for ChBE 413: Data Science in Chemistry and Engineering.
>
> I also understand that Matt Ando was the champion of these X+DS proposals. We tried to finish everything before he left, but the new CIM-P system was not something I saw coming. Anyway, his X+DS initiative is still a great idea. We think it will be a particularly innovative and popular attraction for ChBE at Illinois.
>
> Sincerely,

Baron Peters

From: Amato, Nancy <namato@illinois.edu>
Sent: Thursday, September 14, 2023 2:04 PM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>
Subject: Re: IMPORTANT CHEME+DS course CS info--please read

Hi Baron,

First, let me apologize and 100% agree with you. We have absolutely not be coordinating among the X+DS core providers as we should have, and in the case of your particular degree proposal, I'd like to personally apologize for not being on top of things better. Matt Ando had been operating at the leader of our group, and with his departure over the summer we have not put in place a good alternative structure and as a result we have not been coordinating amongst ourselves before communicating with you. We have a meeting set up for next Wednesday where we will discuss this issue and I am hopeful future X+DS degree proposers will not face the issues that you have.

Related to your ChemE+DS degree, we are truly excited to help you get this through, but we also want to be sure the degree work work for the students and achieve all the learning objectives we have for them.

Now let me apologize again, but I'd like to ask you for some additional information about CheBE 413 that we should have requested before. We have seen a brief description and it sounds like an excellent course, but we'd appreciate if you could share the syllabus with us. This will help us to better evaluate if it could be an appropriate substitute for CS 307.

Again, let me apologize and ask your understanding as we work though this - we are committed to making this process work better for everyone.

-Nancy

On 9/14/23 2:40 AM, Peters, Baron G wrote:

> Dear Professors Gunter, Amato,
>
> CS seems to have me in an infinite loop I know that email threads are tedious, but I hope you can help us escape the loop this time.
>
> We had these discussions with Jeff Douglas, then Mahesh Viswanathan, then Bo Li (from Statistics and CS). Each representative of the committee raises similar concerns. Each decides that we can go forward after adding some language to the proposal. We add the requested text and send it back. And then, instead of gaining approval, a new person in CS answers and starts the discussion again.
>
> Forgive me, but I have to ask … is this group really acting as a committee? I understand that people rotate in and out, but there seems to be no continuity of knowledge about its past decisions. In brief, I will summarize the previous discussions here.
>
> 1. Regarding pre-reqs for STAT 207, the course syllabus (online) says: "Students who completed STAT 100 or 107 previously are welcome. Equally welcome are students in quantitative fields taking STAT 200 [sic] as their first course in statistical analysis." ChBE is a quantitative major with the same early curriculum as the rest of engineering (ENG 100, CS 101, PHYS 200's, CHEM 200's, etc.) Also, Professor Bo Li already considered the pre-reqs in statistics courses. She approved inclusion of STAT 207 (without 107) on behalf of Statistics. I'm happy to send that correspondence if needed.
> 2. In LAS, new majors and new courses for those majors can be proposed concurrently. Both new courses, ChBE 413 and ChBE 415, have been entered in the CIM system, and both are pending approval now.
> 3. Regarding CS 307 vs. ChBE 413: We will not offer ChBE 413 more than once per year. Therefore, many ChemE+DS students will take CS 307, likely more than half. So why include ChBE 413? We want the ChemE+DS curriculum to seamlessly integrate data science with ChBE domain expertise. Throughout the proposal, you will see an emphasis on data science instruction within the context of chemical engineering. In particular, please note the language that we added, at the request of your department, in the Program Description section (and attachments) of the proposal. In short, we believe it is the integration of data science instruction with ChBE domain expertise that will make ChemE+DS something better than a B.S. in ChBE with a disjoint Data Science minor.
> 4. Computer Scientists (especially those at U of Illinois) can run circles around engineers who often approach data science as dabblers and bandwagoners. However, the course in question (ChBE 413) will be taught by Professors Nick Jackson and Diwakar Shukla. Both have won prestigious national awards (NSF CAREER, Sloan, CoMSEF, etc.) for their research on data science in the context of chemistry and chemical engineering. It is hard to imagine better instructors for an integrated data science in chemical engineering course.
>
> ChBE is most nervously waiting on permission from CS to include CS 101, CS 277, and CS 307 in the proposal. That deadline is days away – maybe not even two full days now. The courses in question are just the CS courses in the standard X+DS template. Therefore, this course approval step should be easy.
>
> On the more difficult issue of overall ChemE+DS approval, I am happy to visit Computer Science in person if that helps. In the meantime, Kathy Thomas (our Undergraduate Program Coordinator) will send the proposal with highlights on the previously requested additions that I described in (3). If you would like, we can also organize and assemble the previous correspondences with all parties. …that will be a thick binder, but we're willing to do whatever is needed.
>
> ChemE+DS will be a great program, for ChBE, for COE, and for our students, but it's not going to happen without official approval from Computer Science. I really hope you can look at the past discussions (feel free to share this and discuss with the others) to see that we've already converged on these issues a few times. Thank you for understanding my urgent plea on this.
>
> Sincerely,
>
> Baron Peters
> W. H. and J. G. Lycan Professor
> Director of Undergraduate Studies
> Chemical and Biomolecular Engineering
> University of Illinois at Urbana-Champaign
> https://petersgroup.web.illinois.edu/
> baronp@illinois.edu
> 805-284-8293

From: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Sent: Wednesday, September 13, 2023 3:14 PM
To: Peters, Baron G <baronp@illinois.edu>
Cc: Higdon, Jonathan J L <jhigdon@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: IMPORTANT CHEME+DS course CS info--please read

Please read the email chain below, and we can discuss tomorrow morning with Jon, if you'd like.

Thanks so much,

KATHY THOMAS-STAGG *(SHE/HER)*
Undergraduate Program Coordinator

Chemical and Biomolecular Engineering
99 Roger Adams Laboratory, M/C 712
600 South Mathews Ave, Urbana, IL 61801
217.333.2888| klt7@illinois.edu

From: Gunter, Elsa <egunter@illinois.edu>
Sent: Wednesday, September 13, 2023 2:06 PM
To: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Cc: Herzog, Stephen M <smherzog@illinois.edu>; Newell, Brooke <bsnewell@illinois.edu>; Amato, Nancy <namato@illinois.edu>
Subject: Re: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program

Dear Katie,

I can not speak to the procedural matters for resolving this situation, but I can speak to the perceived difficulties. Since you seem to be asking for specific details, the concerns are on the one hand about prerequisite satisfaction for STAT 207, and through that for CS 277 and CS 307, and on the other, the fact that you are making CS 307 optional with a possible substitution of a class that has not yet been approved as a class, let alone vetted as an appropriate substitution for CS 307. I don't think there is much more I can say about the second issue.

For the first, I have asked David Unger in Statistic whether Statistics has given approval for CS 101 to be an alternate prerequisite for STAT 207. His reply was that the matter had not been put to the Statistics Courses and Curriculum committee, and he asked me for details of CS 101, which I promptly supplied him. I believe that topic is on the C&C committee's agenda. CS 101 is a significantly more thorough introduction to programming than STAT 107. STAT 107 is primarily a statistics course, but the python programming it does teach is focused on statistics applications. CS 101 is focused on calculus and scientific computing applications and does not cover the data packages that STAT 207, CS 277 and CS 307 reply upon as prerequisite knowledge. If Statistics allows CS 101 as a substitution for the prerequisites for STAT 207, then we would like to see at least an assurance from Statistics that STAT 207 will assume the responsibility for providing the needed statistics-orient programming expected from STAT 107. A course revision would be more reassuring.

The decision about whether the substitution of ChBE 413 for CS 307 is acceptable at the level of the program is a matter for the informal X+DS coordination committee, as is the substitution of CS 101 for STAT 107. At the level of courses, I am concerned that we understand how the prerequisites for the CS courses will be satisfied. I am waiting to hear from Statistics for a clarification of that.

---Elsa

On 9/12/23 4:53 PM, Herzog, Stephen M wrote:

> Hi Kathy,
>
> I'm sorry for the delay – we've had transition of associate heads so it wasn't clear in my mind who should even reply to you. I think Elsa Gunter, who now has the job, is the person to reply (though I think she had some questions, too).
>
> Steve
>
> **Steve Herzog** (he/him/his)
> Assistant Director of Undergraduate Programs
> Department of Computer Science
> University of Illinois at Urbana-Champaign
> smherzog@illinois.edu
>
> 1210 Siebel Center for Computer Science
>
> ---
>
> **From:** chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
> **Sent:** Tuesday, September 12, 2023 2:45 PM
> **To:** Herzog, Stephen M <smherzog@illinois.edu>
> **Cc:** chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
> **Subject:** FW: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program
> **Importance:** High
>
> Hi there, Steve.
>
> Brooke suggested I touch base with you with the most recent correspondence that I've had with CS about them approving the 3 courses we need them to approve for the ChemE + DS program submission. (Please see below.) I'm confused by a couple of things that Dr. Amato shared as roadblocks to the approval we are seeking. One is her comment about our proposal not following the recommended template (I am currently inputting all of the required info into the CIM-P portal, so I'm not quite sure what she's referencing and didn't know if you might be able to shed some light on it.). Also, she commented on conferring with her colleagues in STAT, MATH, IS, and CS. STAT, MATH, and IS have already approved the new program and given us the course approval for the courses we'd like to use for the ChemE+DS program that is from their departments. Do you have any thoughts on what I can do to assist in this process so it doesn't get hung up anymore? The 3-course approval is the only thing I need to properly submit our ChemE+DS program. Thank you for any insight or suggestions you may have—I appreciate your expertise!
>
> Thanks so much,
>
> **KATHY THOMAS-STAGG** *(SHE/HER)*
> *Undergraduate Program Coordinator*
>
> Chemical and Biomolecular Engineering
> 99 Roger Adams Laboratory, M/C 712
> 600 South Mathews Ave, Urbana, IL 61801
> 217.333.2888| klt7@illinois.edu

From: Amato, Nancy <namato@illinois.edu>
Sent: Thursday, September 7, 2023 10:25 AM
To: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Cc: Viswanathan, Mahesh <vmahesh@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Fleck, Margaret M <mfleck@illinois.edu>; Peters, Baron G <baronp@illinois.edu>; Rao, Christopher V <cvrao@illinois.edu>; ChBE Director of Undergraduate Studies <chbe-dus@illinois.edu>
Subject: Re: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program

Thanks Kathy - as I mentioned to Baron, we are working through our own internal coordination kinks and will do our best to get back to you asap.

-nancy

On 9/7/23 10:20 AM, chbe-ugprogramoffice wrote:

> Good morning, Nancy.
>
> Thank you for your quick response—I know how busy this time of year can be. I am working with Dr. Peters on the ChemE + DS program proposal, inputting the information, and acquiring the course and program approval letters for the proposal submission. I have already received letters from Statistics, Math, and iSchool in support of the ChemE+DS program using courses from their departments along with approval for our new program (please see attached).
>
> Understandably, there might be some confusion about the template, as the university has changed the program and course proposal templates since we first started this process last year. Since then, I have updated the proposal and am now using the template that is the one the university uses and requires for all of the program proposals, via the CIM portal. (Please see the attached and most current version of our +DS program proposal, as it is not the same format/template as the one you first received earlier this summer.) Can you please clarify what the recommended template is that you're referring to? Thank you for clarifying. CS is the last department we need course approval from in order to submit our +DS proposal, so I'm hopeful we can get these courses approved and any questions answered in time to meet the next deadline here in the next week or two. Thank you for your time and expertise.
>
> Thanks so much,
>
> **KATHY THOMAS-STAGG** *(SHE/HER)*
> *Undergraduate Program Coordinator*
>
> Chemical and Biomolecular Engineering
> 99 Roger Adams Laboratory, M/C 712
> 600 South Mathews Ave, Urbana, IL 61801
> 217.333.2888| klt7@illinois.edu

From: Amato, Nancy <namato@illinois.edu>
Sent: Thursday, September 7, 2023 9:21 AM
To: ChBE Director of Undergraduate Studies <chbe-dus@illinois.edu>; Viswanathan, Mahesh <vmahesh@illinois.edu>; Gunter, Elsa <egunter@illinois.edu>; Fleck, Margaret M <mfleck@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Peters, Baron G <baronp@illinois.edu>; Rao, Christopher V <cvrao@illinois.edu>
Subject: Re: 3rd Attempt: Seeking CS approval for use of CS Courses for the NEW ChemE+DS program

Hi Baron,

Thanks again for your interest in developing a ChemE + DS degree! We are excited to work with you on this.

Since this proposal doesn't follow the recommended template, we will need to discuss with our informal X+DS coordination committee that includes representatives from the four units providing the core (Statistics, Math, iSchool and CS).

I'll reach out to them and we'll try to get back to you soon.

-Nancy

On 9/6/23 11:38 AM, ChBE Director of Undergraduate Studies wrote:

ILLINOIS

COLLEGE OF LIBERAL ARTS & SCIENCES
Department of Chemical & Biomolecular Engineering
114 Roger Adams Laboratory, MC-712
600 S. Mathews Ave.
Urbana, IL 61801

September 6, 2023

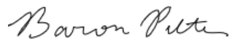
Dear Professor Amato, Professor Viswanathan, Professor Gunter, and Professor Fleck:

I am writing to ask for your endorsement and future cooperation on a new ChemE+DS program. ***A draft proposal for the ChemE+DS program is attached to this message***. The new program will require ChBE students to take some courses in your department. We anticipate approximately 10-40 students per year will enroll in the ChemE+DS program. These students should be allowed, and in some cases will be required, to take the following courses from your department:

CS 101: Intro to Computing for Engineering (Required for ChemE+DS)
CS 277: Algorithms and Data Structures for Data Science (Required for ChemE+DS)
CS 307: Modeling and Learning in Data Science (Optional for ChemE+DS)

With approval from your department, we would like to begin to have students taking these courses in pursuit of ChemE+DS degrees as early as Spring 2024. We have attached a copy of the proposal for this new degree program for your consideration. If you approve, please reply with an official statement of approval and cooperation.

Regards,



Baron Peters
William H. and Janet G. Lycan Professor
and Director of Undergraduate Studies
292 Roger Adams Laboratory
baronp@illinois.edu

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Nancy M. Amato
Abel Bliss Professor and Head, Department of Computer Science
University of Illinois at Urbana-Champaign
2232 Siebel Center, 201 N. Goodwin Ave., Urbana IL 61801
+1-217-333-3426, namato@illinois.edu
head@cs.illinois.edu (for scheduling or administrative contact)
++

PS. We have some great postdoc openings: the department's Future Faculty Fellows program (https://go.cs.illinois.edu/fff)

PPS. Check out iCAN (Illinois Computing Accelerator for Non-Specialists), a 1-year program for non-computing college graduates. A bridge to a career in tech or grad studies. Applications for our 4th cohort are open now!
http://cs.illinois.edu/ican

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http://cs.illinois.edu/ican

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Elsa L Gunter
Research Professor
Associate Head for Academics
Department of Computer Science
University of Illinois at Urbana - Champaign

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http://cs.illinois.edu/ican

From: Peters, Baron G
To: Viswanathan, Mahesh; Gunter, Elsa; chbe-ugprogramoffice
Subject: RE: ChBE+DS proposal
Date: Wednesday, August 9, 2023 11:34:00 PM
Attachments: Chemical Engineering + Data Science 8-8-23.pdf

Dear Mahesh and Elsa,

Thank you for the message about the proposed ChemE+DS program. And thank you for the helpful suggestions earlier this summer.

We fully appreciate the importance of STAT 107 as an intro to statistics and to python programming. However, our proposal ultimately omitted STAT 107. Professor Bo Li said that STAT 107 would support the proposal, but asked us to include the explanation for omission of STAT 107 in the program description section of the proposal (attached). The reasons are summarized here, for your convenience:

==========

Statistics training: The ChemE+DS proposal requires both STAT 207 and ChBE 411.

- Sophomore level ChemE+DS students will take STAT 207 (Data Science Exploration). The STAT 207 syllabus says "Students who completed STAT 100 or 107 previously are welcome. Equally welcome are students in quantitative fields taking STAT 200 as their first course in statistical analysis." Our students (and probably many other STEM+DS majors) will be able to start directly in STAT 207 without STAT 107.

- As juniors, the ChemE+DS students will take ChBE 411 (Probability and Statistics for Chemical Engineering) in lieu of STAT 400. ChBE 411 is a calculus-based probability and statistics course. It covers the same major topics as Stat 400. However, the examples, homework, and exams in ChBE411 are built around chemical engineering applications. These include parameter estimation from reaction rate data, Poisson statistics problems related to catalyst preparation, survival probability data in nucleation assays, polymer conformations and sequence statistics, regression applied in the context of chemical equilibrium and Van't Hoff analyses, categorical data in characterization of chemically functionalized surfaces, non-parametric tests that arise in particle size distribution data, propagation of uncertainties through relations between fluid flow and transport phenomena, and confounding effects in mechanistic studies of catalysis and biochemical processes. The domain-specific training gives our students an opportunity to reinforce their chemical engineering foundations and simultaneously learn probability and statistics in the context of realistic chemical engineering applications.

Programming training:

- CS 101 is a Python based programming course. All engineering majors (including ChBE and ChemE+DS) have to take CS 101, and they typically take this course in the Freshman year. We recognize that CS 101 is not equivalent to STAT 107, but with two other statistics courses in the curriculum we feel that CS 101 is critical and STAT 107 is not.

- ChBE 412 (Computational Methods in Chemical Engineering) also focuses on Python programming, with challenging problem sets involving root finding, optimization,

numerical integration, differential equation solvers, etc. in the context of chemical engineering problems.

- Several other courses in the proposed curriculum also reinforce the students' Python programming skills: ChBE 413, Math 257, and CS 307.

In reviewing the Stat 400 and Stat 107 courses, we identified two key additions that will be made to ChBE 411.

• The terminology used in past versions of ChBE 411 was not always aligned with proper terminology as introduced in Stat 107 and Stat 400. For example, our students learn experimental designs and hypothesis testing procedures for data that is grouped by strata, but they do not learn that this is called "stratification". To avoid creation of unnecessary language barriers for our students, we will improve the alignment of ChBE 411 with established data science terminology.

• Previous versions of ChBE 411 did not include an introduction to data clustering algorithms, a key part of many data science applications and a topic that students do see in STAT 107. We will add a lecture and homework assignment on clustering algorithms to ChBE 411 starting in Fall 2023.

Stat 107 includes a machine learning introduction lecture. ChBE 411 does not include an introduction to machine learning (but it does include two weeks of lectures on linear regression and analysis of variance tools). ChBE 411 will not go deeper into machine learning because the students will get in depth lessons on these topics in the Stat 207, ChBE 413, and CS 307 courses.

In summary, the proposed ChemE+DS curriculum already requires 132 credit hours, so adding STAT 107 will complicate the path to four-year graduation. We recognize that STAT 107 is essential for X+DS programs when the area of specialization ("X") is a non-STEM subject. However, ChemE+DS students see the STAT 107 content at early stages in their area of specialization. Because of this, we believe STAT 107 can be omitted with no detrimental effects to their training.

My apologies for the long message. I hope this answers the questions, and that we might get confirmation of support from Computer Science soon. We are all set to submit this proposal for approval in LAS. The deadline is approaching soon – and we can't wait to offer this exciting new major. Thank you for all that you've done to create the opportunity.

Sincerely,
Baron Peters
W. H. and J. G. Lycan Professor

Director of Undergraduate Studies
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign
https://petersgroup.web.illinois.edu/
baronp@illinois.edu
805-284-8293

From: Viswanathan, Mahesh <vmahesh@illinois.edu>
Sent: Wednesday, August 9, 2023 9:14 AM
To: ChBE Director of Undergraduate Studies <chbe-dus@illinois.edu>
Cc: Gunter, Elsa <egunter@illinois.edu>
Subject: ChBE+DS proposal

Dear Barron,

My name is Mahesh Viswanathan. I am currently Associate Head for Academic for CS. I am including Prof. Elsa Gunter, who will be taking over from me in a week.

I am writing to discuss the ChBE+DS degree proposal. There is some concern among the Stat and CS faculty about replacing STAT/CS 107 with CS 101. As currently setup, the degree proposal would not meet the pre-requisites for STAT 207. Have you had discussions with Statistics about this? Are they on board with this change?

If it is easier to talk about please let me know and I will set up a meeting.

Mahesh.

Mahesh Viswanathan

Professor and Associate Head

Department of Computer Science

University of Illinois, Urbana-Champaign

https://vmahesh.cs.illinois.edu/

Peters, Baron G

From: Peters, Baron G
Sent: Thursday, August 10, 2023 12:14 AM
To: Li, Bo; chbe-ugprogramoffice
Subject: revised program description
Attachments: Chemical Engineering + Data Science 8-8-23.pdf; ChemE + DS Program Description.docx

Dear Professor Li,

Thank you for the super fast response last week on the ChemE+DS program. I have attached in this email a revised proposal. The justification for STAT 107 omission did not fit in the blank, but our undergraduate program coordinator (Kathy Thomas-Stagg) has added that as an attachment included here. Thank you again for the fast response. I hope this answers the questions, and that we might now get confirmation of support from Statistics. I look forward to starting this exciting new major. Thank you for all that you and your department has done to create the opportunity.

Sincerely,
Baron Peters
W. H. and J. G. Lycan Professor
Director of Undergraduate Studies
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign
https://petersgroup.web.illinois.edu/
baronp@illinois.edu
805-284-8293

PROGRAM DESCRIPTION

Proposed effective catalog term: Spring 2024

Bachelor of Science in Chemical Engineering plus Data Science

1) Provide a brief, concise description (not justification) of your proposal.

We propose a degree plan that combines a strong foundation in chemical engineering with training in data science principles, techniques, and practices. The program includes a traditional core sequence in chemical engineering classes with additional data science coursework requirements (comparable to a minor) and a data science practicum. The proposed degree is comprised of three different components:

1. The data science core coursework (44 hours)
    a. This coursework is comprised of:
        i. One (1) course from Statistics (STAT 207)
        ii. Two (2) course from Computer Science (CS 277 and CS 101)
        iii. Two (2) courses from the iSchool (IS 467 and IS 477)
        iv. Five (5) courses from Mathematics
        v. ChBE 411
        vi. ChBE 412
        vii. CS 307 or ChBE 413
2. The coursework in the area of specialization (65 hours)
3. Discovery experiences (ChBE 415 planned, 3 hours)

The proposed curriculum deviates from the standard X+DS core in two key ways. We have omitted STAT 107 and we replaced STAT 400 with a domain-specific calculus-based probability and statistics course (ChBE 411). The reasons for these modifications are explained below:

STAT 107 provides introductions to statistics, data science, and Python programming. We appreciate the critical importance of all three topics, but ChemE+DS students will learn Python, statistics, and data science in other early courses. For programming in Python:

1) CS 101 is a Python based programming course. All engineering majors (including ChBE and ChemE+DS) have to take CS 101, and they typically take this course in the Freshman year.
2) ChBE 412 (Computational Methods in Chemical Engineering) also focuses on Python programming, with challenging problem sets involving root finding, optimization, numerical integration, differential equation solvers, etc. in the context of chemical engineering problems.
3) Several other courses in the proposed curriculum also reinforce the students' Python programming skills: ChBE 413, Math 257, and CS 307.

ChemE+DS students will also obtain a rigorous training in statistics. They will first encounter statistics as sophomores in STAT 207. Then as juniors, the students will take ChBE 411 (Probability and Statistics for Chemical Engineering) in lieu of STAT 400. ChBE 411 is a calculus-based probability and statistics course. It encompasses nearly all topics from Stat 400 and Stat 107. However, the examples, homework, and exams in ChBE411 are built around chemical engineering applications. These include parameter estimation from reaction rate data, Poisson statistics problems related to catalyst

preparation, survival probability data in nucleation assays, polymer conformations and sequence statistics, regression applied in the context of chemical equilibrium and Van't Hoff analyses, categorical data in characterization of chemically functionalized surfaces, non-parametric tests that arise in particle size distribution data, propagation of uncertainties through relations between fluid flow and transport phenomena, and confounding effects in mechanistic studies of catalysis and biochemical processes. The domain-specific training gives our students an opportunity to reinforce their chemical engineering foundations and simultaneously learn probability and statistics in the context of realistic chemical engineering applications.

In reviewing the Stat 400 and Stat 107 courses, we identified two key additions that will be made to ChBE 411.

- The terminology used in past versions of ChBE 411 was not always aligned with proper terminology as introduced in Stat 107 and Stat 400. For example, our students learn experimental designs and hypothesis testing procedures for data that is grouped by strata, but they do not learn that this is called "stratification". To avoid creation of unnecessary language barriers for our students, we will improve the alignment of ChBE 411 with established data science terminology.

- Previous versions of ChBE 411 did not include an introduction to data clustering algorithms, a key part of many data science applications and a topic that students do see in STAT 107. We will add a lecture and homework assignment on clustering algorithms to ChBE 411 starting in Fall 2023.

Stat 107 includes a machine learning introduction lecture. ChBE 411 does not include an introduction to machine learning (but it does include two weeks of lectures on linear regression and analysis of variance tools). ChBE 411 will not go deeper into machine learning because the students will get in depth lessons on these topics in the Stat 207, ChBE 413, and CS 307 courses.

: CHEMICAL ENGINEERING + DATA SCIENCE

New Proposal
Changes saved but not submitted
Viewing:: Chemical Engineering + Data Science
Proposal Type

Proposal Type:

Major (ex. Special Education)

Administration Details

Official Program Name

Chemical Engineering + Data Science

Diploma Title

Bachelor of Science in Chemical Engineering + Data Science

Sponsor College

Liberal Arts & Sciences

Sponsor Department

Chemical and Biomolecular Engineering

Sponsor Name

Professor Christopher Rao, PhD.

Sponsor Email

cvrao@illinois.edu

College Contact

Stephen R. Downie

College Contact Email

sdownie@illinois.edu

College Budget Officer

Michael Wellens

College Budget Officer Email

wellens@illinois.edu

List the role for rollbacks (which role will edit the proposal on questions from EPC, e.g., Dept Head or Initiator) and/or any additional stakeholders. Purpose: List here who will do the editing work if proposal needs rolled back. And any other stakeholders.

Professor Baron Peters - baronp@illinois.edu
Kathy Thomas-Stagg - chbe-ugprogramoffice@illinois.edu

Does this program have inter-departmental administration?

No

Proposal Title

Effective Catalog Term

Spring 2024

Proposal Title (either Establish/Revise/Eliminate the Degree Name in Program Name in the College of XXXX, i.e., Establish the Bachelor of Science in Entomology in the College of Liberals Art and Sciences, include the Graduate College for Grad Programs)

Establish the Bachelor of Science in Chemical Engineering + Data Science in the College of Liberal Arts and Sciences

Does this proposal have any related proposals that will also be revised during the next 6 weeks? Consider Majors, Minors, Concentrations & Joint Programs in your department. Please know that this information is used administratively to move related proposals through workflow efficiently. Example: If you are revising the BS proposal and one related concentration within the next 6 weeks, "This BS proposal (key 567) is related to the Concentration A proposal (key 145)."

In the next several weeks, we will be updating the CHBE program (Key 734) information via the CIM-P portal due to the form change and will be adding around 600 new technical electives to the CIM-P application for CHBE. We will also be adding four new courses for the ChemE+DS Program, CHBE 413 (Key13383), CHBE 415 (Key 13384), CHBE 513 and CHBE 515. We will also be adding CHBE 459 and CHBE 461 to our CHBE course curriculum (These were past CHBE 494 courses that are now permanent courses in the CHBE program.), which serves as part of the new ChemE+DS program curriculum.

Program Justification

Provide a brief justification of the program, including highlights of the program objectives, and the careers, occupations, or further educational opportunities for which the program will prepare graduates, when appropriate.

Rapid growth in digital computing power and device interconnectivity have made it possible to acquire and rapidly analyze massive amounts of data. These data science advances have already transformed commerce, social networks, and even our language, c.f. “google (v)” in Merriam-Webster. Indeed, data science is emerging as a subject of great importance in many domains of human and scholastic endeavor. There is substantial demand, both from students and from employers, for educational programs in data science. A 2017 study by researchers at IBM and Burning Glass Technologies predicts the demand for Data Scientists will grow by 28% by 202 . Enrollment in the undergraduate majors of “Statistics” and “Statistics and Computer Science,” which provide students access to some of the competencies of data science, have grown by a factor of six in the last ten years.

Data science is currently transforming science and engineering, offering practical fast solutions as an alternative to first principles analyses wherever adequate data can be procured. As these technologies become more prevalent in the engineering profession, we as educators have a duty to prepare our students to use them effectively, safely, and ethically. National policy documents for data science majors emphasize that engagement with an application domain is an important part of data science education. The University of Illinois’ white paper on data science education recommended “X +DS Majors” as an innovative approach to offering broad collaborative opportunities for Illinois students to engage with data science.

The proposed ChemE+DS degree will both prepare our students for the future and enhance their understanding of traditional chemical engineering concepts. Traditional ChBE (like many branches of engineering) mixes first-principles science with practical, powerful, data-driven empiricisms. For example, the correlations that we use for heat, mass, and momentum transfer are rooted in first-principles dimensional analysis, combined with scaling relations and empirical correlations. The data-driven elements of these correlations make them practical and applicable for extremely complex situations, while their starting point (balance equations that identify dimensionless combinations of inputs) makes them transferrable across a range of materials and conditions.

In these past applications of data science, data sets were small and the governing equations were available (if not solvable) to identify all of the relevant variables. Accordingly, engineers made progress with simple statistical analysis tools. Now, large multidimensional data sets require more sophisticated techniques. It is critical that we train chemical engineers on state-of-the-art data science tools and data curation practices to meet the challenges of this new era. It is equally critical that chemical engineers learn about the potentially catastrophic pitfalls of complete reliance on past data in decisions about the future.

Modern data science presents a tremendous opportunity to chemical and biomolecular engineering, but the full power of data science (as seen in our traditional ChBE correlations) will come from a judicious combination of data science and chemical engineering foundations. For this reason, students with a balanced education in both chemical engineering and data science will be uniquely poised to harness the data science revolution for applications in the chemical engineering and the chemical sciences.

Students who graduate from this program will enter the workforce with the technical skills to construct models, to analyze, interpret, and visualize data, and to make data-driven decisions in light of technology, economic, and safety/ethics considerations. These skills will give our ChemE+DS graduates a unique edge in the chemical industry.

Instructional Resources

Will there be any reduction in other course offerings, programs or concentrations by your department as a result of this new program/proposed change?

No

Does this new program/proposed change result in the replacement of another program?

No

Does the program include other courses/subjects outside of the sponsoring department impacted by the creation/revision of this program?

Yes

Courses outside of the sponsoring department/interdisciplinary departments

MATH 221 - Calculus I
MATH 231 - Calculus II
MATH 241 - Calculus III
MATH 257 - Linear Algebra w Computat Appl
MATH 285 - Intro Differential Equations
STAT 207 - Data Science Exploration
CS 307 - Model & Learning in Data Sci
CS 101 - Intro Computing: Engrg & Sci
CS 277 - Algo & Data Stru for Data Sci
IS 467 - Ethics & Policy for Data Scien
IS 477 - Data Mgmt, Curation, & Reprodu
ENG 100 - Engineering Orientation
CHEM 202 - Accelerated Chemistry I
CHEM 203 - Accelerated Chemistry Lab I
CHEM 204 - Accelerated Chemistry II
CHEM 205 - Accelerated Chemistry Lab II
CHEM 236 - Fundamental Organic Chem I
CHEM 237 - Structure and Synthesis
CHEM 442 - Physical Chemistry I

CHEM 420 - Instrumental Characterization
CHEM 315 - Instrumental Chem Systems Lab
PHYS 211 - University Physics: Mechanics
PHYS 212 - University Physics: Elec & Mag
PHYS 214 - Univ Physics: Quantum Physics

Program Regulation and Assessment

Plan to Assess and Improve Student Learning

Illinois Administrative Code: 1050.30(b)(1)(D) Provision is made for guidance and counseling of students, evaluations of student performance, continuous monitoring of progress of students toward their degree objectives and appropriate academic record keeping.

List the program's student learning outcomes. Each outcome should identify what students are expected to know and/or be able to do upon completing this program.

Student learning outcomes are based on learning outcomes in line with the ABET accreditation process.

Chemical Engineering graduates will have:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.

2.An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.

3. An ability to communicate effectively with a range of audiences.

4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.

5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

7.An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Describe how, when, and where these learning outcomes will be assessed.

Describe here:

Course and Student Outcomes are directly and quantitatively measured in undergraduate core chemical engineering courses each semester. Adjustments and changes to lectures, problem sets, course projects and course emphasis are based on student performance on specific outcomes. The assessment process was applied to the core courses and quantitative and qualitative assessment of student performance, based on specific outcomes, have significantly shaped course improvement and instruction.

At the individual course level, course outcomes are developed by the faculty teaching that course with input from the entire faculty and are described within the individual course syllabi. Each of the course outcomes are matched with relevant student outcomes. Our approach for evaluating student achievement of outcomes involves instructors completing spreadsheets each semester for core courses. In their entirety, the documentation contained within the outcomes assessment spreadsheets directly and quantitatively demonstrates the achievement of student outcomes and tracks course improvement. Our spreadsheet-based process for documenting and measuring the achievement of our outcomes involves several steps:

1. Each instructor or teaching team develops and documents their course outcomes, with input from the faculty.

2. Each instructor designs assessment tools (exams, quizzes, projects, homework assignments, etc.) for each course outcome. These course outcomes are then mapped to student outcomes.

3. Each instructor determines the acceptable level of achievement for each outcome for which students as a whole will be assessed. These attainment levels typically range from 60% to 75% depending upon the type and difficulty of the assessment tool and course material.

4. Each instructor, with the help of a TA, compiles overall student achievement levels for each assessment tool and compares this average to the predetermined minimum achievement level.

5. If any outcome is not achieved, instructors suggest changes or possible reasons for the achievement level below the minimum acceptable level. These course improvements can also be prompted by lower than expected student performance on specific assessment instruments, instructor observations of the course, or best practices in engineering education.

6. In subsequent semesters, the instructors or teaching team close the loop and implement their suggested changes. Individual instructors adjust lectures, problem sets and course deliverables in response to course assessments. Once a change has been implemented, it is evaluated for efficacy. If an outcome is still not being achieved, further modifications are considered. These suggestions for modification can be instructor-derived, or solicited from other faculty, from a faculty, subcommittee, annual Curriculum Assessment and Review meeting, or from one of the various teaching support resources available to faculty outlined in Criterion 8. This process of iterative continuous improvement is performed each time the course is offered.

7. Faculty members submit spreadsheets documenting items 1 through 6 as well as graded samples of all assessment tools which directly measure the achievement of one or more course outcomes tied to one or more student outcomes. This documentation is reviewed for completeness and archived by the Assessment Committee.

Extensive quantitative assessment of student outcomes is reviewed every six years.

Additional qualitative assessment are performed based on instructor observation, which prompt additional course improvements. Individual course spreadsheets, along with course improvement suggestions, samples of graded student work, and annual curriculum meeting minutes are collected and archived by the Assessment Committee every semester and can be made available if desired.

Graduating Student Survey

Senior students are surveyed starting 1-2 months before graduation to collect feedback on outcomes achievement and overall perception of the program. The graduating senior survey is kept open and available for completion for 1-2 months after graduation. This survey is conducted twice a year to allow every student an opportunity to provide feedback, as some students graduate in December. One important aspect of this survey is collecting feedback on the students' own perceived level of achievement of the student outcomes. Though these data are self-reflective, it is an important aspect of assessment since it helps us gauge the students' perceived level of preparedness, achievement and confidence at the time of graduation.

Students are asked to rate on a 1-5 scale their perceived level of achievement of the student outcomes.

For all surveys, any qualitative suggestions are documented and grouped based on topic. The quantitative and qualitative results of the Graduating Senior Survey are compiled, documented, and presented to the faculty once a year. Faculty discussion and resulting action items are documented in the Faculty Curriculum meeting minutes. Often action items are delegated to a sub group of faculty, such as the Undergraduate Curriculum Committee, for further analysis and suggested action if warranted.

Identify faculty expectations for students' achievement of each of the stated student learning outcomes. What score, rating, or level of expertise will signify that students have met each outcome? Provide rating rubrics as necessary.

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Indirect Assessments/Informal Data Sources

To augment Alumni and Employer Surveys which often have very low response rates, the department head and other faculty meet with alumni and recruiters/employers, as many are alumni, when they visit campus. Representatives from industry visit faculty and the department head on a regular basis. Every year many recruiters visit campus and several of them meet with faculty and the Head formally or informally. These visits provide the department with an opportunity to collect feedback from alumni. This may include suggestions for improvement of the program and the effectiveness of our placement office in helping recruiters. We also host alumni as guest speakers for courses (3 to 6 every spring for the Introduction to Chemical Engineering Profession course, and some for Unit Operations and Design) and as judges (e.g., 2 to 4 for our undergraduate research symposium, 2 to 3 for our design across the curriculum competition). These visitors typically meet with the Head, a number of faculty, and student organizers. As a part of our alumni stewardship program, we invite a group of alumni back to campus for a formal or informal seminar. Faculty meet with the alumnus guest one-on-one, and also schedule 4 to 10 undergraduates to meet with the visitor.

Explain the process that will be implemented to ensure that assessment results are used to improve student learning.

Annually CHBE faculty hold a Curriculum Assessment and Review meeting. Within this meeting a representative from each core CHBE course reports assessment information, overall perceptions of student strengths, and areas in need of improvement. This meeting is an opportunity to discuss the curriculum as a whole and the propagation of student skills throughout the program. Facilitating smooth transitions from a prerequisite class to a higher level course are discussed and improvements to strengthen the prerequisite course or its structure are evaluated. Specifically, evaluations of overall student strengths and areas in need of improvement are conducted by the faculty teaching the capstone courses, design (CHBE 431) and unit operations (CHBE 430) who continuously evaluate and improve the curriculum through a holistic approach. If the results of this annual Curriculum Assessment and Review meeting suggest the need for significant changes in course structure or coverage, these concerns are referred to the Undergraduate Curriculum Committee for consideration.

Program Description and Requirements Attach Documents

ChemE + DS Degree Requirements.docx
ChemE + DS Program Description.docx

Is the career/profession for graduates of this program regulated by the State of Illinois?

No

Program of Study

Baccalaureate degree requires at least 120 semester credit hours or 180 quarter credit hours and at least 40 semester credit hours (60 quarter credit hours) in upper division courses" (source: https://www.ibhe.org/assets/files/PublicAdminRules2017.pdf). For proposals for new bachelor's degrees, if this minimum is not explicitly met by specifically-required 300- and/or 400-level courses, please provide information on how the upper-division hours requirement will be satisfied.

Catalog Page Text - Overview Tab

Description of program for the catalog page. This is not official content, it is used to help build the new catalog page for the program. Can be edited in the catalog by the college or department.

This major is sponsored jointly by the Departments of Statistics, Computer Science, iSchool, Mathematics, and Chemical and Biomolecular Engineering. The Chemical and Biomolecular Engineering+Data Science major is designed for students who would like a strong foundation in Data Science with a deep B.S. level specialization in Chemical and Biomolecular Engineering. The major prepares students for professional or graduate work in Chemical and Biomolecular Engineering with additional mastery of statistics, data analysis, data modeling, machine learning, and other Data Science topics.

Statement for Programs of Study Catalog

This major is sponsored jointly by the Departments of Statistics, Computer Science, iSchool, Mathematics, and Chemical and Biomolecular Engineering. The Chemical Engineering + Data Science major is designed for students who would like a strong foundation in Data Science with a deep B.S. level specialization in Chemical and Biomolecular Engineering. The major prepares students for professional or graduate work in Chemical and Biomolecular Engineering with additional mastery of statistics, data analysis, data modeling, machine learning, and other Data Science topics.

Corresponding Degree

BS Bachelor of Science

Program Features

Academic Level

Undergraduate

Does this major have transcripted concentrations?

No

What is the typical time to completion of this program?

4-4.5 years

What are the minimum Total Credit Hours required for this program?

132 hrs

CIP Code

307099 - Data Science, Other.

Is This a Teacher Certification Program?

No

Will specialized accreditation be sought for this program?

Yes

Describe the plans for seeking specialized accreditation:

We will seek ABET accreditation for the ChemE+DS degree program. Note that ABET accreditation does not require assessments for every course. We will seek accreditation of ChemE+DS mainly based on assessments of the Chemical Engineering components. The core components of the Chemical Engineering degree remain complete in the ChemE+DS proposal and these are already being assessed. The only potential challenge in accreditation will be to gain approval for some +DS core requirements that as “engineering design” electives. We will attempt to justify this designation for CS 307, CS 277, and IS 467. We only need to successfully gain approval for engineering design elective status in one of these courses to meet accreditation requirements. We do not anticipate a need for any assistance from Computer Science, Statistics, Math, or Information Sciences in this effort.

Delivery Method

This program is available:

On Campus - Students are required to be on campus, they may take some online courses.

Admission Requirements

Desired Effective Admissions Term

Spring 2024

Provide a brief narrative description of the admission requirements for this program. Where relevant, include information about licensure requirements, student background checks, GRE and TOEFL scores, and admission requirements for transfer students.

Applicants will be admitted in the fall and spring semesters. Requirements for Incoming Freshmen follow the general admission requirements of the University and current ChBE admission requirements. English proficiency is a must and this can be assessed by taking the TOEFL, IELTS, or Duolingo English Test. Calculus is preferred for first year admitted students (if offered in their high school). Students must also demonstrate understanding of and interest in Chemical Engineering.

For inter-college transfer students (ICT) there are several specific requirements. Students must hold a GPA of 3.1 or greater for at least 2 semesters of work (Cannot pad your GPA with independent study courses or underload with coursework that is not favorable). Students must have a grade of C or better in two of the following ChBE courses: ChBE 221, 321, or 421. The department will also review other ChBE courses the student has taken to determine the ability to succeed within Chemical engineering. Lastly, students must develop a graduation plan to be approved by the head advisor or a faculty /staff member designated by the department head. The graduation plan must not include multiple difficult classes within the same semester such as ChBE 430, 431, 440 and CHEM 315 taken in the same semester.

For transfers from another university, they will need to possess a grade point average of 3.2 or higher. Preference is given to those that can complete a degree requirement within a total of ten semesters (not counting summer sessions). Availability of transfers is also based on space availability. If transferring with more than 80 credit hours of coursework, an additional review is required.

Enrollment

Number of Students in Program (estimate)

Year One Estimate

10

5th Year Estimate (or when fully implemented)

100-120

Estimated Annual Number of Degrees Awarded

Year One Estimate

5-10

5th Year Estimate (or when fully implemented)

25-30

What is the matriculation term for this program?

Fall

Budget

Will the program or revision require staffing (faculty, advisors, etc.) beyond what is currently available?

No

Financial Resources

How does the unit intend to financially support this proposal?

This is a revision of an existing degree program to partner with a data science component, and the anticipated effects are mainly shift in course enrollments that are already offered within the ChBE, CS, STAT, MATH, and IE units. New courses largely shift enrollments between participating units who are well-established already. Because of this and the lack of need for any additional faculty, staff, or additional resources, we do not expect any of these shifts or changes to cause a need for new costs with the introduction of this degree program.

Will the unit need to seek campus or other external resources?

No

What tuition rate do you expect to charge for this program? e.g, Undergraduate Base Tuition, or Engineering Differential, or Social Work Online (no dollar amounts necessary)

Engineering Differential

IBHE

Degree Program Title and Overview

What is the specific title of the proposed degree program as it would be listed in the IBHE Program Inventory? The name should be what typically is used for similar programs nationally. Provide a short description of the program, including highlights of the program objectives, and the careers, occupations, or further educational opportunities for which the program will prepare graduates.

Chemical Engineering + Data Science

Illinois Administrative Code: 1050.30(a)(1): A) The objectives of the unit of instruction, research or public service are consistent with the mission of the college or university; B) The objectives of the unit of instruction, research or public service are consistent with what the unit title implies.

Institutional Context

University of Illinois at Urbana-Champaign

Describe the historical and university context of the program's development. Include a short summary of any existing program(s) upon which this program will be built.

Explain the nature and degree of overlap with existing programs and, if such overlap exists, document consultation with the impacted program's home department(s).

The University of Illinois at Urbana – Champaign became the first university to host a digital computer in 1952, and it has remained a leading institution in Computer Science since that time. Illinois and its alumni have contributed include core hardware, logic, and math operations that remain in use today, as well as ubiquitous parts of our digital experience like PayPal, YouTube, and the digital library. Illinois continues to host the national center for supercomputing applications (NCSA). Illinois' tradition of excellence in Computer Science draws thousands of top STEM applicants each year.

UIUC is also home to one of the nation's first Chemical Engineering departments. Since its founding in 1901, the department has consistently been ranked among the best in the nation. Our alumni include CEOs and CTOs of multinational corporations like General Electric, Dow, PPG, Shell, and International Paper. Our alumni also include numerous past and present NAE caliber academics. The undergraduate program, currently ranked 8th in the nation, draws excellent undergraduate applicants from Illinois.

Computation and data sciences are already important topics within the chemical engineering curriculum. Our students take all of the required math courses for an X+DS degree. They are required to complete one of two rigorous probability and statistics courses. And "computational methods" is one of our most popular undergraduate electives. Clearly math, statistics, and computing are already viewed as essential skills within ChBE. Our faculty and students are unanimously excited about the development of this new program.

University of Illinois

Briefly describe how this program will support the University's mission, focus and/or current priorities. Demonstrate the program's consistency with and centrality to that mission.

The Public Agenda for Illinois Higher Education aims to direct policies and resources based on career needs of Illinois residents and to address current and future economic needs of Illinois. Data scientists transform raw data into meaningful, actionable conclusions – a task that is critical for all modern industries. According to the Bureau of Labor Statistics, data science and data analytics is a growing market nationwide. Illinois in particular has one of the nation's highest location quotients, i.e. data analytics positions are a higher share of the job market in Illinois than in most other parts of the country. The jobs pay extremely well, with a nationwide average of $108K/yr.

We emphasize that the salary figure above is for the broad discipline of Data Science. The mean wage for a Chemical Engineer is $122K/yr. We anticipate that the unique combination of Chemical Engineering + Data Science will draw higher salaries than chemical engineering alone. Data science has transformed Chemical Engineering research in the past decade. The research efforts have been enthusiastically embraced by both industry and academia, suggesting that Data Science will soon be integrated in standard chemical engineering jobs and curriculum. The proposed ChemE+DS program will prepare Illinois' next generation of chemical engineers for this coming transformation.

Note that Chemical Engineers are essential to petroleum refining, which is not a major industry in Illinois, but also to the chemicals industry, to agriculture and fertilizer production, and to the manufacturing of everything from food to paints and coatings. All the latter are important industries in Illinois, and all these industries would benefit from a local supply of Chemical Engineers with unique Data Science training. If we can act quickly, Illinois has the opportunity to be among the first ChemE+DS programs, creating a unique pool of STEM expertise in Illinois.

Discuss projected future employment and/or additional educational opportunities for graduates of this program. Compare estimated demand with the estimated supply of graduates from this program and existing similar programs in the state. Where appropriate, provide documentation by citing data from such sources as employer surveys, current labor market analyses, and future workforce projections. (Whenever possible, use state and national labor data, such as that from the Illinois Department of Employment Security at http://lmi.ides.state.il.us/ and/or the U.S. Bureau for Labor Statistics at http://www.bls.gov/).

The chemical engineering job market is highly competitive. In recent years the number of new job openings has been comparable to the number of chemical engineering graduates, and the market (26800 total jobs according to the bureau of labor) is growing slowly. In contrast, the total number of data science jobs (106000 total jobs according to the bureau of labor) is larger and growing faster. ChemE+DS graduates will not qualify for most of the massive data science job openings, but (to our knowledge) no other university has a chemical engineering + data science degree program at the undergraduate level. Thus even a few hundred data science jobs that require chemical engineering domain expertise would give our graduates an enormous advantage.

It is increasingly recognized that team members with domain expertise are critical for data science project success. Some understanding of the foundations is invaluable for building useful models and software, because even black-box models require specification of the relevant input and

output variables. Belyadi and Haghighat write “If a data scientist has no practical experience in an industry, it is extremely difficult to understand relationship between variables.” [Machine Learning Guide for Oil and Gas with Python, Elsevier (2021)]. For these niche jobs, there is reason to believe our ChemE+DS graduates will be even more desirable than top candidates from Computer Science or Statistics programs.

What resources will be provided to assist students with job placement?

Students will have access to the School of Chemical Sciences Career Service Department as well as the Grainger College of Engineering’s Career Service Department. The school of Chemical Sciences has 3 academic advisors and 2 staff in their Career Services Department. Grainger College of Engineering has 14 staff in their Undergraduate Program Office, 6 staff in the Computer Sciences Office, and 20 other staff in various engineering department offices.

The School of Chemical sciences helps to facilitate and support Connections between employers and job seekers. They help with job searches for full time employment as well as summer/semester internships and co-ops. They use the platform Handshake@Illinois to notify students of job and internship opportunities. They also have on-campus employment interviews and many programs to help students prepare for those interviews. Those programs include mock interviews, resume and cover letter reviews, and workshops to aid students during each step of the recruitment process. They also host a fall and spring engineering career services career fair at the Illini Union.

Chemical Engineering Students also have access to the Grainger College of Engineering Career Services Department and receive job opportunities, employer events and career event information through Handshake@illinois. Grainger also has opportunities for professional development presentations and resume reviews sessions held by Engineering Ambassadors. They have mentoring through an extensive alumni network via the Grainger Engineering Link.

If letters of support are available attach them here:

Kenis, Paul - approval letter 2023.pdf
Rao, Chris - approval letter 2023.pdf

Comparable Programs in Illinois

Illinois Administrative Code: 1050.30(a)(6): B) The unit of instruction, research or public service meets a need that is not currently met by existing institutions and units of instruction, research or public service. For additional information about similar programs, check the Degree Program Inventory on the IBHE website (https://www.ibhe.org/ProgInv_Prog.aspx) and review the Notice of Intent website for programs being planned (http://legacy.ibhe.org/ODA/tracking/NOI/NOISearch.asp).

Identify similar programs and sponsoring institutions in the state, at both public and private colleges and universities. Compare the proposed program with these programs, and discuss its potential impact upon them. Provide complete responses, do not reference website links.

Currently, there are no other programs/majors, at the undergraduate level, like the one being proposed by ChBE in Illinois, the U.S., or internationally.

A Thriving Illinois: Higher Education Paths to Equity, Sustainability, and Growth

IBHE is charged to develop a strategic plan to address the present and future aims and needs and requirements of higher education in Illinois (110 ILCS 205/6) (from Ch. 144, par. 186) Sec. 6). Illinois Administrative Code:

1050.30(a)(6): A) The unit of instruction, research or public service is educationally and economically justified based on the educational priorities and needs of the citizens of Illinois Respond to the following questions about how the proposed program will support the three goals of A Thriving Illinois: Higher Education Paths to Equity, Sustainability, and Growth Strategic Plan.

Equity

Describe institutional-level plans to close equity gaps in access, progression, completion, and attainment and the implications for the proposed program. More specifically, provide institutional-level plans for attracting, recruiting, retaining, and completing a diverse group of students including working adults, students of color, transfer and low-income students and implications for the proposed program. Explain how progress will be monitored.

8a Equity: Describe institutional-level plans to close equity gaps in access, progression, completion, and attainment and the implications for the proposed program. More specifically, provide institutional-level plans for attracting, recruiting, retaining, and completing a diverse group of students including working adults, students of color, transfer and low-income students and implications for the proposed program. Explain how progress will be monitored. [See Equity Strategy #2]

Institutional level plans to address equity gaps.

The University of Illinois System recognizes the significance of bridging equity gaps among its citizens in order to fulfill its mission. The University of Illinois actively works to address equity disparities among individuals throughout Illinois, both in urban and rural areas.

A Thriving Illinois, Equity Strategy #2: These are strategies set forth by the IBHE to attain equitable access to higher education. See ibhestrategicplan.ibhe.org/SP_Equity_Strategies.html. Pursuant to these goals, the UI System's Access 2030 Strategic Plan aims to increase the number of graduates from underrepresented groups by 50 percent by the end of the decade. This initiative encompasses students from disadvantaged backgrounds, including those from ethnic and racial minorities, rural areas, and urban communities. It reinforces the University of Illinois' commitment to serving the public good by ensuring that no communities are left behind while striving to improve life in the state. Additionally, it builds upon existing efforts to foster opportunities for individuals of all backgrounds in Illinois.

Scholarships: The university also supports underrepresented groups and underrepresented counties through the President's Award Program (PAP), totalling over $15 million / yr. PAP scholarships are given for $5000/yr up to 4 years, and the PAP Honors program scholarships are $10000/yr for 4 yrs. Both provide assistance to students from underrepresented groups across the UI System.

Student recruitment and retention: The University of Illinois runs the Salute to Academic Achievement (SAA). SAA invites students from underrepresented groups and counties to the college-fair event according to their GPA, test scores, and high school nominations. Participants meet with college, admissions, financial aid, and housing representatives from universities in the UI System. They further receive application fee waivers for UI system universities. In 2021, approximately 4600 students were invited and over 10% attended.

The University of Illinois Urbana-Champaign also has outreach and recruitment programs specifically designed for historically underrepresented minority students, including Discover Illinois and Días de Visita en Español.

The university actively participates in several other student retention initiatives. As part of the American Talent Initiative (ATI) the University of Illinois Urbana-Champaign has set the following goals: 1. increase the six-year graduation rate for Pell students to 81% for the 2017 entering cohort; 2. increase targeted opportunities for incoming students to participate in summer scholar/bridge programming in an attempt to increase the number of Pell students enrolling, improve retention rates, and reduce graduate rate gaps for this population.

As part of the Association of Public and Land Grant Universities Powered by Publics (APLU PxP) both to increase graduation rates and expand access to education for all students. The goals of APLU PxP are to produce several hundred thousand more degrees by 2025; to eliminate the achievement gap for low-income, minority, and first-generation students; and to expand access to higher education for students from all backgrounds. One hundred thirty (130) universities and state systems participate in 16 transformation "clusters."

UIUC leads the Big Ten Academic Alliance (BTAA), which studies trends in retention and barriers faced by students. In addition to student retention, the BTAA tracks course "DFW" (D grades, F grades, and Withdrawals) to understand and address specific bottlenecks (across institutions) in student success. UIUC is using the results to identify courses where additional support is needed for students. For example, BTAA institutions shared information on DF grades in the first semester. The graduation gap between students who had one D/F grade in their first semester vs. those with no DF grades was 19.9%; the gap for those with multiple D/F grades was 47.3%.

The Student Success Initiative (SSI) at UIUC aims to enhance student success through improved access, equity, and overall experience. Goals include increasing access, reducing costs, and providing financial aid. It also strives to close equity gaps by improving retention and graduation rates for underrepresented students. The SSI promotes inclusive campus programs and support services, organizes events like the Student Success Symposium, and implements projects like the Mental Health Working Group and Faculty and Staff Mental Health Ambassador Program. It addresses COVID-related learning loss and streamlines the Learning Management System. In the upcoming year, the SSI will focus on enhancing first-year and transfer student experiences, increasing access for underrepresented students, and providing professional development for faculty to ensure quality outcomes.

The Morrill Engineering Program is to empower African American, Hispanic, and Native American engineering students, support their success as scholars, and enable them to leverage a community of students, staff, and alumni to achieve excellence in engineering. The MEP program hosts a variety of activities throughout the year to enhance the student experience.

Transfer guarantee program: This program guarantees admission to one of the three UI system campuses if a student (i) graduated from an Illinois high school, (ii) attended an Illinois community college, (iii) attained 36 graded credit hours and a minimum 3.0 GPA, and (iv) satisfy the UI system language requirement. The transfer guarantee program provides an affordable path to a four-year degree for economically disadvantaged students, pursuant to Growth Strategy #8 by the IBHE. The University of Illinois Urbana-Champaign coordinates several seamless transfer programs with community colleges. The Parkland Pathway allows students to simultaneously enroll at Parkland College and UIUC while living in UIUC residence halls. UIUC also coordinates advising services with City Colleges of Chicago, Danville Area Community College, Illinois Central College, and Rock Valley College.

Test optional policies: The university has adopted a test-optional policy, making ACT/SAT scores optional for first-year applicants. The test-optional policy is part of a shift toward more holistic application criteria, motivated by the strong correlation between standardized test scores and socioeconomic background. Merit-based and honors programs also do not require test scores for consideration.

The Academic Redshirt in Science and Engineering (ARISE) program prepares talented students from the state of Illinois to succeed in Engineering at Illinois. Up to 25 students are named ARISE scholars every year, giving them an extra year to get ready for traditional first-year courses. The program includes a customized curriculum, individual faculty mentors, tutoring, and career services.

Common app: Starting in 2022, the University of Illinois became part of the Common App program, which allows students to easily and inexpensively apply to numerous universities. The Common App program also helps guidance counselors at schools with limited resources easily scale their efforts in helping students. ChBE applications jumped approximately 20% in the year that the common app began.

Office of the Vice Chancellor for Diversity, Equity, and Inclusion (OVCDEI): The University of Illinois Urbana-Champaign (UIUC) has a strong focus on diversity, equity, and inclusion. The OVCDEI leads these efforts, impacting students, faculty, and staff. Student-focused programming sets the tone for equity strategies. A campus-wide climate assessment will be launched in the 2022-2023 academic year to gauge students' sense of safety, acceptance, and value. The university collaborates with external organizations, peer institutions, and the Association of American Universities (AAU) to ensure the assessment is comprehensive and benchmarked against peers.

Chancellor's Call to Action to Address Racism and Social Injustice: UIUC is committed to equity through the Call-to-Action program which has funded 22 selected proposals in 17 departments, for approximately $2 million annually.

College, Department, and Program-level plans

The Department of Chemical Engineering recognizes the importance of diversity in gender, ethnicity, sexual orientation, disability status, national origin, religion, and socio-economic status. We understand that diverse talent is a strategic asset that allows for more effective research and teaching. We believe in a scientific culture that aspires to the highest standards of professionalism, promotes psychological safety and encourages respect for others, so everyone can bring their best creative selves to the department.

The Department of Chemical and Biomolecular Engineering (future home of ChemE+DS) aims to create an inclusive and discrimination-free environment for all. A recent National Academies report highlighted challenges related to sexual harassment and faculty accountability within the science and engineering community. To address these issues, the department plans to establish a community-based approach through continuous feedback, advocacy, and proactive policies. Initiatives to improve climate and diversity include setting workplace expectations, conducting faculty workshops on personnel management, establishing a Program Climate Review Committee, and discussion of mental health, anti-racism policies, and sexual harassment training in syllabi and courses. Our students benefit from several services and opportunities within the Chemical Engineering department, the School of Chemical Sciences, the College of Liberal Arts and Sciences, and the College of Engineering. The include the following services, scholarships, and student organizations:

Student organizations that help to create a cohesive community for underrepresented students include the National Organization for Professional Advancement of Black Chemists and Chemical Engineers (NOBCChE), Society for Advancing Chinos/Hispanics & Native Americans in Science (SACNAS), and the Annual Biomedical Research Conference for Minority Students (ABRCMS).

The Claire Boothe Luce (CBL) program aims to support women undergraduates seeking to study or teach science, mathematics, and/or engineering, creating a pathway to graduate studies. Each year, eight women undergraduates are selected to take part in the Illinois Scholars Undergraduate Research program and work closely with a faculty sponsor/graduate student mentor on research projects.

The department also supports students from underrepresented groups and backgrounds through numerous scholarships including:

Corn Family Scholarship: Awarded to chemical engineering students, with a preference for women and/or underrepresented students.

Chester W. Hannum Scholarship: Awarded to able and needy students in the Department of Chemistry or Department of Chemical and Biomolecular Engineering.

Dr. Jerrod A. Henderson Scholarship: Awarded to students based on merit who contribute to the diversity of the student body in the unit.

Kenneth E. Jaconetty Scholarship: Awarded to students who contribute to the diversity of the student body in the unit, established to combat institutional racism and promote inclusivity.

John W. Latchum Jr. Scholarship: Awarded to chemical engineering students with financial need and a strong work ethic.

Marchoe Dill Northern Scholarship: Awarded to underrepresented students in chemical engineering.

Pathways to Success Scholarship: Designed to attract traditionally underrepresented students in chemical engineering, offered to outstanding incoming freshmen.

Describe program and institution-based high-impact practices and wrap-around student support services ensuring equitable access and success for students enrolled in the proposed program.

The pandemic had a disproportionate impact on students from low-income and minority families, amplifying existing challenges in higher education. To help students regain their pre-pandemic learning trajectory, the IBHE recommends extending learning opportunities, providing proactive advising, and offering wrap-around supports are also essential. High-impact practices, tailored for underrepresented minority students, such as service learning, research opportunities, and internships, contribute to student success and retention. Additional wrap-around support (those provided by an extended team of professionals like family, health workers, teachers, financial advisors, etc.) are also important components.

The University of Illinois Urbana-Champaign takes pride in its leadership on high-impact practices and services for students. These support practices foster ongoing learning renewal and the implementation of evidence-based approaches, aligning with Equity Strategy #1 of A Thriving Illinois. Students have access to resources such as the Counseling Center, Office of the Dean of Students, McKinley Health Center, and Student Assistance Center, which are available in-person or remotely to promote student wellness and retention. The university's Writer's Workshop offers workshops and writing assistants to assist all students with their writing projects. Disability Resources & Educational Services (DRES) has also played a significant role in supporting students with disabilities, contributing to the university's reputation as a national leader in post-secondary education for individuals with disabilities. DRES is responsible for numerous innovations:
• The first architectural accessibility standards that later became the American National Standards Institute Standards;
• The first wheelchair-accessible fixed route bus system;
• The first accessible university residence halls;
• The first university service fraternity and advocacy group for students with disabilities, Delta Sigma Omicron; and
• The first university to receive the Barrier-Free America Award from the Paralyzed Veterans of America (2012).

The Counseling Center, McKinley Health Center, and Student Assistance Center are easily accessible to all students, whether in-person or remotely, to enhance student well-being and retention. Students are encouraged to participate in Writer's Workshop activities, and writing assistants are available to provide support on course projects. These services, in combination with DRES, have helped to establish Urbana-Champaign as the leader in post-secondary education for individuals with disabilities.

The Office of Inclusion and Intercultural Relations (OIIR) offers several programs aimed at supporting diverse student groups, including working adults, students of color, and transfer and low-income students. OIIR is home to UIUC's cultural and resource centers, as well as various impactful programs. Three examples of these programs are the 100 STRONG Program, I-Connect Diversity & Inclusion Workshops, and Housing Division Social Justice and Leadership Education. Appendix C provides a more comprehensive list of programs, including those specifically designed for African American and Latino/a students. The Chez Veterans Center, located within the College of Applied Health Sciences, provides support for veterans, including personalized academic and career coaching, mentoring opportunities, and health and wellness services to enhance overall well-being.

The Office of Minority Student Affairs (OMSA) at the University of Illinois Urbana-Champaign is a long-standing and extensive student support program that reflects the university's commitment to its land-grant mission. OMSA has been dedicated to promoting access for all students and offering a wide range of college preparatory and support services to enhance student success since its establishment. OMSA's programs, such as AMPS (Academic Mentoring, Programs, and Services), align with Equity Strategy #8 of A Thriving Illinois by incorporating near-peer mentoring and staff as mentors/coaches.

The Illinois Scholars Program (ISP) serves Illinois residents from historically underserved populations and counties with low college attendance rates. ISP facilitates a smooth transition for entering students by offering educational, personal, social, and cultural opportunities. The program begins with a rigorous four-week summer bridge experience for incoming first-year students, and it continues to provide ongoing support and community throughout the students' undergraduate years. The program outcomes are correlated to student success. Over 100 students have successfully completed the summer bridge experience, resulting in 93.9% retention from freshman to sophomore year. This retention rate surpasses the campus average of 91.5% for underrepresented minority students.

The University of Illinois System has introduced the Access 2030 initiative to increase the number of graduates from underrepresented groups by 50% by the end of the decade. The initiative focuses on ethnic and racial minorities from disadvantaged backgrounds in rural and urban areas. Access 2030 is intended to promote equity and diversity across the U of I System universities. Each university will develop tailored plans, encompassing student readiness, recruitment, retention, and graduation, with support systems like mentoring and bridge programs. The initiative seeks to close equity gaps from K-12 through college, building on the universities' previous efforts that have already increased enrollment of underrepresented students by over 68% in the past decade. Systemwide retention rates for these students are on par or exceed national averages.

College, department, and program-level high-impact and wraparound support services

The School of Chemical Sciences (SCS) offers excellent wrap-around services including academic advisors and career services professionals who specialize in helping Chemical Engineering students. SCS Advising and Career Services plan to provide these services for ChemE+DS if the new major is approved.

SCS Career Services office seeks to provide guidelines, resources, and opportunities to SCS job seekers to help them achieve their career aspirations and to facilitate connections between employers and those job seekers. They provide guidance for careers in industry, for higher education, and for practical experiences like internships and co-ops. Specific examples of popular services include job search coaching, mock interviews, professional development workshops, and assistance with resumes, CVs, and cover letters.

SCS Advising – Our students benefit from a team of advisors with specific Chemical Engineering expertise. The advisors help students with a number of conventional services, e.g. course selection, navigating of university and department policies, degree planning (e.g. with a roadmap to 4-yr graduation), and monitoring academic progress. The SCS Advisors also help students with wrap-around services like setting personal goals, career positioning, and finding resources like writing centers and counselors. SCS advisors are understanding of students' life situations and experiences, and they work with students whenever possible to accommodate their diverse needs.

C² at the University of Illinois Urbana-Champaign promotes excellence among underrepresented Chemistry and Chemical Engineering majors. C² facilitates partnerships with graduate student mentors and organizes monthly networking and professional development events. The program fosters a scholarly community where diversity and excellence flourish. Additionally, C² offers one-on-one peer mentorship, professional development workshops, networking opportunities, and the chance to apply for Summer Research Scholarships and competitive Travel Awards for research presentations at national conferences.

The Shell Tutoring Program (sponsored by Shell Oil Co.) supports hourly pay for peer tutors. Shell tutors are selected from a competitive pool of applicants to provide our undergraduates with focused assistance in core Chemical Engineering course material. The Shell tutors hold office hours and study sessions where students can learn by working with peers in an informal setting.

ChBE Learning Centers: ChBE offers several Learning Centers for undergraduate student use. The facilities feature computers, printers, study areas, and whiteboards for group study.

The Research Park, a University facility in Champaign, IL, collaborates with various industry-focused initiatives and organizations. Many internship opportunities at the Research Park promote diversity, equity, and inclusion in Science, Technology, Engineering, and Mathematics. Examples include Synchrony's sponsorship of FOCUS Scholars and the Motorola Solutions' partnership with the National Society of Black Engineers. Moreover, the Research Park works closely with affinity and community groups on campus, maintaining partnerships with units like La Casa Cultural Latina, the Bruce Nesbitt African American Cultural Center, and The Career Center, as well as student groups such as the Society of Women Engineers, and Alpha Omega Epsilon (professional women's leadership sorority). These opportunities provide unique experiences for Illinois' diverse students in the Research Park. Additionally, the Illinois Reboot tech training program offers a free data science course to underrepresented Central Illinois professionals, with 61 percent of its 150 trainees since 2020 coming from underrepresented populations. Reboot also provides career coaching and access to Research Park data science professionals.

The Campus-Community Compact (Compact) is a major initiative of UIUC's Call to Action to Address Racism and Social Injustice. It is a co-equal partnership between UIUC and the Champaign-Urbana community, aiming to accelerate social justice by addressing structural racism, bias, and social injustice in six grand challenge areas: inclusive education, accessible technology, economic development, health, wellness, and resilience, workforce development, and community relations. Additionally, the Compact includes crosscut areas like accessible campus/transportation, accessible information, community safety, and language (e.g., multilingualism, communications, and messaging). The initiative seeks to make significant progress over the next 5-10 years.

Explain institutional strategies being implemented to increase and retain faculty, staff, and administrators of color and the implications for the proposed program. Explain how progress will be monitored.

Pursuant to IBHE Equity Strategy #3, the UI System supports efforts to cultivate and retain underrepresented minority faculty. In particular, the Distinguished Faculty Recruitment Program has a stated goal of increasing underrepresented minority faculty. Since 2017, the System has committed $20 million to this program, the recruitment of tenured, star, or rising faculty from a range of disciplines who can transform our universities by their exceptional scholarship and teaching.

The Public Voices Fellowship is a year-long program open to tenured faculty to join a cohort of leaders, the majority of whom will be underrepresented (including women) and provide them with extraordinary support, leadership skills, and knowledge to ensure their ideas shape not only their fields, but also the greater public conversations of our age. The Leadership Initiative for Women Faculty brings together women faculty from across the UI System who are leaders and/or potential leaders to identify barriers to and facilitators for advancement of women. Finally, the System will also be providing funding in support of each university's faculty recruitment plans which will also emphasize the recruitment of underrepresented minority faculty.

The University of Illinois Urbana-Champaign is making strategic investments in faculty recruitment to uphold our academic strengths, address student needs, and seize new opportunities. These investments are particularly important in the competitive market for top talent. The Next 150 strategic plan

includes an initiative to expand our faculty in key areas over the next five years. The hiring initiative was hindered by the COVID-19 pandemic, but the university remains committed to its efforts to hire diverse faculty.

Specific hiring decisions are largely left to departments and colleges, but the campus has allocated significant resources to encourage diversity in the hiring process. Two prominent programs in this regard are the Targets of Opportunity Program (TOP) and the Dual Career Academic Couples (DCAC) program. The TOP program offers ongoing financial support in the form of salary funds to facilitate the recruitment of faculty who enhance campus diversity, with a specific focus on underrepresented groups and women in STEM fields. These hires are typically identified through conventional search processes, but faculty search committees must document their efforts to reach and interview diverse applicants. Additionally, the Office of the Provost, in collaboration with the Office of the Vice Chancellor for Diversity, Equity, and Inclusion, recently introduced a temporary modification to the TOP program to foster the recruitment of more faculty of color. This initiative has made an additional approximate sum of $1 million available to units to support hiring efforts in this specific area. For the DCAC program, the Provost provides recurring matching funds equivalent to one-third of the initial salary if the partner is hired into a tenure track position through the DCAC program. The DCAC program was recently extended to include non-recurring funds for partner hires in non-tenure track positions.

The Provost's Underrepresented Faculty Recruitment Program offers non-recurring research funds to strengthen employment offers. For individuals hired during the 2022-2023 academic year, grants of up to $20,000 per year were available for each of the first three years of employment. The Provost's Office allocates funds to cover supplementary search expenses when candidates from underrepresented groups visit campus.

The Office of the Provost is also investing in faculty development. Starting from recruitment and onboarding, all the way through promotion and retirement, faculty members are provided with tailored programming and resources to address their specific career needs. Additionally, the office extends support for institutional memberships that grant access to external resources for our faculty. Examples include access to the National Center for Faculty Development and Diversity (NCFDD) and the Collins Scholars programs.
Additional programs and resources to enhance retention are made available to executive officers and faculty members at all ranks. These initiatives equip unit executive officers with skills to effectively support and mentor faculty, with a specific emphasis on faculty members of color. Additionally, the Provost's Office organizes leadership development programs aimed at expanding the pool of potential academic leaders. These programs intentionally prioritize campus leadership and administrative roles for faculty members from marginalized and underrepresented groups.

To track the effectiveness of our diversity, equity, and inclusion efforts in faculty recruitment and retention, we gather, oversee, and publish yearly data through the Division of Management Information and Office for Access and Equity.

College, department, and program-level efforts to recruit and retain faculty, staff, and administrators of color

Chemical and Biomolecular Engineering has fully embraced the University emphasis on efforts to hire diverse faculty and staff. Each hiring committee includes a specific diversity advocate. The diversity advocate ensures that all committee members are aware of best practices and that all members have completed the DiversityEdu program within three years of the search. The Diversity Advocate also helps to shape the position advertisement strategy to reach a diverse pool of qualified applicants. Finally, the diversity Advocate documents the good faith efforts to advertise the position and adhere to best practices throughout the search. Good faith efforts include several required advertising locations: U of I job board, HigherEd Jobs and Affirmative Action Email, Illinois Diversity, Big Ten Academic Alliance Directory, and Diversifying Higher Education Faculty in Illinois Program, and National Professional Journal (in our case, The American Institute for Chemical Engineering (AIChE) Journal). [?? Add to list ??] In recent faculty and specialized teaching faculty searches, our finalists (selected for on-site interviews) were mostly women and underrepresented minorities. In our last four faculty and teaching faculty searches, we successfully hired one black woman, one white male, and two white women.

Retention and support for diverse faculty are paramount priorities in Chemical and Biomolecular Engineering. We works to create a supportive environment that addresses the unique needs and challenges faced by diverse faculty. We strive to ensure that diverse faculty feel supported, valued, and encouraged to thrive in their academic pursuits, thus enriching the educational experience for all members of our campus community. Diverse faculty serve on committees at every level of leadership. They are encouraged to take parental teaching release to make time for family and maintenance of their research programs. New faculty are also given one semester of teaching release to establish their research programs and/or finalize preparations for tenure review. Faculty also meet with mentors to plan for award nominations, to set professional goals, and to discuss their support needs.

Sustainability

Describe strategies and initiatives the institution plans to implement that makes the proposed program and college more generally affordable for students and their families, including those who have been historically underserved.

Institution-level affordability plans

The University of Illinois Urbana-Champaign and the UI System have demonstrated a strong commitment to enhancing college affordability, particularly for historically underserved populations. They have implemented various initiatives including the President's Award Program (PAP) and PAP Honors. The PAP and PAP Honors programs support students from underrepresented groups with an annual award of $5,000/yr for up to 4 years and $10,000/yr for 4 years, respectively. Over $250 million has been distributed through these programs.

The State of Illinois AIM HIGH Grant program provides $5,000/yr awards to top academically admitted new freshmen.

Incoming Liberal Arts and Sciences (LAS) students at the University of Illinois are automatically considered for scholarships administered by the college. The information from your application for admission is used for scholarship consideration. For need-based scholarships, the information from the Free Application for Federal Student Aid (FAFSA) is used for scholarship selection. Continuing students apply for scholarships through a central application portal, with criteria again considering both merit and need. The availability of one centralized application portal helps to ensure that scholarship funds are utilized. The typical number of scholarships awarded is ca. 130 accouting for approximately $500,000 per year of support. As noted in item 8a, the Chemical and Biomolecular Engineering department and the School of Chemical Sciences, and the College of Engineering each offer additional scholarship opportunities to our students.

The University of Illinois at Urbana-Champaign also helps to mitigate financial barriers to higher education through financial aid. The university offers over $465 million / yr in financial aid to undergraduate students, benefiting 72% of the student body. A significant portion of this funding, amounting to over $145 million, is derived from institutional sources and primarily awarded as need-based grants and scholarships to Illinois residents. The university has two notable financial aid programs. The Illinois Promise program, initiated in 2005, covers tuition, fees, housing, and books/supplies through a combination of federal, state, and institutional grants, along with a $2,500 Federal Work-Study award. It is available to Illinois residents from families with income at or below the federal poverty level. The Illinois Commitment program, launched in 2019, provides grants to cover tuition and fees for Illinois residents with a family income of $67,100 or less. Approximately 30% of Illinois residents attending UIUC receive funding through the Illinois Promise or Illinois Commitment programs. Notably, of the 2020-2021 cohort of Illinois Commitment recipients, 36% identify as Hispanic, 28% as White, 19% as Black/African American, 14% as Asian, and 3% identify as two or more races.

Finally, to alleviate financial constraints that impact retention, the University of Illinois at Urbana-Champaign recently changed the threshold past-due balance that prevents course registration. This had been imposed on any student with a past-due balance of $200 or more. Now the sanction is imposed on students with a past-due balance of $1500 or more, pursuant to Sustainability Goal, Strategy 3 of A Thriving Illinois.

Provide tuition cost analysis for comparable programs and institutions in Illinois.

UIUC Chemical Engineering + Data Science, $22,836 tuition + fees per year
Northwestern University, BS in Data Science, $64,887 tuition per year
Northwestern University, BS in Chemical Engineering, $64,887 tuition per year
University of Chicago, BS in Data Science, $63,801 tuition per year
University of Illinois at Chicago, BS in Chemical Engineering, $18,594 tuition + fees per year

Growth

Provide a supply and demand analysis for the proposed program that, at minimum, does the following: a) Provides evidence of student interest in the proposed program including any strategies to incentivize students to stay in Illinois. b) Identifies and provides evidence of a high-quality credential with viability for future careers.

a) Incentives for Students in the Program

According to Bureau of Labor Statistics, Data Science employment opportunities are expected to grow by 31% in the next decade, so the high demand for these skills will undoubtedly continue. At the same time, it is increasingly recognized that domain expertise is critical for data science projects in applied settings. Domain expertise is especially important in engineering contexts, where the optimal solution often relies on a judicious mixture of fundamental science, engineering design heuristics, economic considerations, and data driven models. AI and data science are progressing rapidly, but most engineering problems are currently too complex for a pure AI/data science approach. We believe the most fruitful skillset, at least for the near future, is a mixture of chemical engineering foundations with proficiency in state-of-the-art data science tools. We further anticipate that students with this unique training will ultimately lead the industry in all aspects of chemical process automation and analysis.

Currently, there is no combined Chemical Engineering + Data Science program at the BS level anywhere in the world. We believe the University of Illinois (if administration stops changing the template!) can be the first to offer this unique major, and that it will draw students from across the nation. We have been careful not to promise ChemE+DS program, but discussions with prospective students and parents suggest that a ChemE+DS program would indeed be a desirable major. Computer Science at the University of Illinois at Urbana-Champaign receives approximately 10,000 applicants per year, and admits only 10% of these applicants. Data Science is a major portion of their curriculum and in reciprocal fashion, Computer Science courses are a major portion of all X+DS degrees.

We stress that our principal goal is to offer an innovative major that will prepare our students for a changing workplace. However, the ChemE+DS program will undoubtedly also help us recruit top engineering talent at the undergraduate level.

b) Department/Program Evidence of a High-Quality Credential with Viable Future Careers

Illinois is a lead in science and technology research and development, making it an ideal state for data scientists to land high powered, high paying jobs. In 2016, data scientists working in Illinois' major cities earned an annual starting salary between $80,000 and $190,000 on average. The thriving tech base is largely attributed to the state's elite research centers, international institutes, and innovative laboratories including:

• Argonne National Laboratory
• Fermi National Accelerator Laboratory
• National Center for Supercomputing Applications
• Gas Technology Institute
• National Center for Food Safety & Technology
• USDA National Center for Agriculture Utilization Research

Major Illinois-based employers of Chemical Engineers and Data Scientists include

• BP facilities including research offices and Whiting Refinery
• Archer-Daniels-Midland Headquarters and numerous Illinois facilities
• Abbott Laboratories
• AbbVie Pharmaceuticals
• ConAgra Brands
• Accenture Consulting

There is little we can do to influence students' decisions and life-plans post-graduation. Moreover, the nationwide demand and intense competition for our graduates is a point of pride in Chemical Engineering. However, the technology sector in Illinois, including data science positions, is growing. The region encompassing Chicago, known as the Technology and Research Corridor, is home to numerous other tech businesses, scientific institutes, government agencies, logistics companies, colleges and universities, and international firms like Microsoft, McDonald's, and Toyota. Employment opportunities in Illinois tend to offer comparable salaries to those in tech hubs like Silicon Valley and Seattle, but with a significantly lower cost of living.

Explain how the program engaged with business and industry in its development and how it will spur the state's economy by leveraging partnerships with local, regional, and state industry, business leaders and employers.

Institutional engagement

The University of Illinois Urbana-Champaign has strong partnerships with business and industry through the Discovery Partners Institute (DPI) and the Illinois Innovation Network (IIN). DPI's Tech Talent Lab and immersion programs engage students with Chicago's technology workforce, fostering connections with regional employers, research teams, nonprofits, and startups. The university-industry links promote employment and talent retention in the area. IIN enhances the student experience through short-term boot camps focused on essential topics like artificial intelligence, data science, and entrepreneurship, cultivating interest and providing a solid foundation for future studies in these areas.

The Research Park offers industry-focused research and internships. It employs 800 year-round interns, allowing UIUC undergraduate and graduate students to work part-time on campus while remaining full-time students. It hosts more student workers than any other peer US university research/tech park. Students receive highly competitive wages for their specialized skills in fields like computer science, data analytics, engineering, business development, and human resources. Many interns are classified as Federal Work-Study participants. Research Park internships enhance employment prospects by expanding professional networks, building portfolios, and developing leadership skills.

Describe how the proposed program will expand access and opportunities for students through high-impact practices including research opportunities, internships, apprenticeships, career pathways, and other field experiences.

Institution level high-impact practices

An example at DPI is the City Scholars program, which pairs top engineering students with Chicago tech companies for semester-long internships. Engineering City Scholars work 20 hours per week at a paid internship with Chicago tech companies, making connections and building a competitive career-focused resume.

As noted in the previous response, the Research Park expands access and opportunities for students by employing 800 interns year-round in part-time research opportunities and career-relevant internships, allowing University of Illinois Urbana-Champaign undergraduate and graduate students to work on campus and be enrolled as full-time students.

In an effort to establish or enhance sustainable outreach and partnerships with PreK-12 schools, the Chancellor at the University of Illinois Urbana-Champaign established the position of Associate Chancellor for PreK-12 Initiatives in August 2021. This new position creates partnerships with superintendents statewide as well as identifies and partners with key education stakeholders to attract and retain undeserved and underrepresented students. It allows us to rethink and enhance the high school to college pipeline in Illinois by partnering with organizations such as Chicago Scholars, Hope Chicago, the Discovery Partners Institute (DPI), Illinois Innovation Network (IIN), and the Jackie Joyner-Kersee Foundation. Hope Chicago, for

example, works with Chicago Public School graduates to ensure they have the financial and wraparound supports necessary to be successful in obtaining a degree by providing a student success program, career services, alumni outreach, and program performance goals.

This new initiative reconceptualizes the important role higher education must play in ensuring Illinois learners gain the confidence and comprehension for college. The ultimate goal of this initiative is to ensure that the University of Illinois Urbana-Champaign has developed structural outreach and partnerships to systemically close persisting opportunity gaps in our state's school systems.

The Office of Undergraduate Research (OUR) is guided by the philosophy that all Illinois undergraduate students should learn about current disciplinary research, take part in research discussions, and be exposed to research experiences in their regular coursework. Furthermore, where practical, an advanced research experience should be among the capstone options in all major programs of study. Undergraduate research opportunities should be designed to support the pedagogical goals and the research mission of the university. To achieve its mission, OUR seeks to: 1) inspire students and faculty to collaborate on research projects driven by mutual interests by fostering a research mentoring environment that encourages and rewards collaboration; 2) disseminate best practices and models for undergraduate research to campus stakeholders; 3) assist in the development and evaluation of curricular and co-curricular structures that support undergraduate research; 4) encourage the creation of new opportunities for undergraduate research on campus and 5) coordinate and nurture undergraduate research efforts across academic units on campus.

College, department, and program level high-impact practices

The presence of a substantial research or discovery experience is an integral part of the X +DS degree initiative at UIUC. Akin to the BS in Accountancy + DS and BS in Finance + DS, the curriculum of the BS in Business + DS also involves such an experience. One of the most important skills a student will gain in the BS in Business +DS will be the ability to present data in meaningful ways. A meaningful research and experience is as much a pillar of this degree program as both the core coursework in Data Science and the area of business specialization. This capstone experience can be fulfilled through BUS 301, listed in the Business Core curriculum. This course is an active learning, real-client experience that will allow students to join their data science skills with their business skills.

Explain how the proposed program will expand its models of teaching and learning, research, and/or public service and outreach that provide opportunity for students to succeed in the work of the future.

Institution level expansion of models

Based in the College of Agricultural, Consumer and Environmental Sciences, U of I Extension works with all colleges and units of the University of Illinois Urbana-Champaign. Extension's core program areas are Agriculture and Natural Resources, Family and Consumer Sciences, Youth Development, Community and Economic Development, and Outreach and Innovation Initiatives. More than 1.5 million Illinois residents take part in University of Illinois Extension programs each year, including nearly 200,000 who participate in 4-H youth programs. Communities are directly served by Extension staff in 27 units located throughout Illinois. Extension educators in local offices and specialists located at the university develop and deliver in-depth programming locally, at regional venues, and through distance-learning technologies.

College, department, and program expansion of models

As noted in previous passages, competence in Data Science very much correlates with the work of the future. The vast amounts of data that have been acquired by private and public organizations over the last decade involve the possibilities to broadly improve the welfare of our state and the nation. Yet, the number of workers who are trained in the skills to analyze this vast amount of data and provide appropriate future directions for business and governments remains insufficient. This proposed program will train the workers of tomorrow who will be able to make sense of the digitization of our world and thereby provide substantial gains for the State of Illinois.

Beyond workforce need, describe how the program broadly addresses societal needs (e.g., cultural or liberal arts contribution, lifelong learning of Illinois residents, or civic participation).

Program's Addressing of Societal Needs

Data Science has the potential to improve both, standard of life and quality of life in many ways. It can help people make better decisions, solve problems, and discover new insights. It also has the potential to help us solve some of the world's most pressing problems.

Nonprofit organizations, like private corporations, may use data analytics tools to analyze information gathered during operations. In a survey of 460 nonprofit professionals, 90% said their organizations are collecting data, 46% said their data is spread across multiple systems and software platforms, and 50% said they use software to collect and analyze data as part of their email programs and donor management processes. In a separate Salesforce survey of over 450 nonprofit professionals, 53% collect program data, 47% analyze program data, 46% track the effectiveness of programs, and 41% quantify the overall impact of programs.

Government agencies gather data for a better understanding and growth of the nation and its well-being. They get public sector data like housing, health care, education, and national security. They also bring this through census data, labor and employment statistics, finance data, meteorological data, and geographic data.

Current data analytics methods increase the accuracy of social and economic forecasting. Yet government officials have difficulty accessing the data they want for their prediction models.

One of the more visible data-driven organizations is Change.org, a website that runs campaigns that aim to save lives and change laws. A second example is the Food and Drug Administration (FDA), which announced plans to utilize data analytics to combat the opioid crisis. Another example of data-driven organizations in action, Community Technology Alliance (CTA), was founded to develop data-driven solutions to poverty and homeless. The platform Ginger.io uses data to provide behavior health coaching, therapy, and self-led guides and assessments.

Program Description and Requirements

Illinois Administrative Code:

1050.30(b)(1) A) The caliber and content to the curriculum assure that the objectives of the unit of instruction will be achieved; B) The breadth and depth of the curriculum are consistent with what the title of the unit of instruction implies; C) The admission and graduation requirements for the unit of instruction are consistent with the stated objectives of the unit of instruction.

1050.30(b)(3): Appropriate steps shall be taken to assure that professional accreditation needed for licensure or entry into a profession as specified in the objectives of the unit of instruction is maintained or will be granted in a reasonable period of time.

1050.50 (a)(2)(C) Requirement for Programs in which State Licensure is Required for Employment in the Field: In the case of a program in which State licensure is required for employment in the field, a program can be found to be in good standing if the institution is able to provide evidence that program graduates are eligible to take the appropriate licensure examination and pass rates are maintained as specified in the objectives of the unit of instruction. If there is no such evidence, the institution shall report the program as flagged for review.

Program Description

Provide a description of the proposed program and its curriculum, including a list of the required core courses and short ("catalog") descriptions of each one. (This list should identify all courses newly developed for the program).

Provide Program Description here:

We propose a degree plan that combines a strong foundation in chemical engineering with training in data science principles, techniques, and practices. The program includes a traditional core sequence in chemical engineering classes with additional data science coursework requirements (comparable to a minor) and a data science practicum. The proposed degree is comprised of three different components:

1. The data science core coursework (44 hours)
a. This coursework is comprised of:
i. One (1) course from Statistics (STAT 207)
ii. One (1) course from Computer Science (CS 277)
iii. Two (2) courses from the iSchool (IS 467 and IS 477)
iv. Five (5) courses from Mathematics
v. ChBE 411
vi. ChBE 412
vii. CS 307 or ChBE 413
2. The coursework in the area of specialization (65 hours)
3. Discovery experiences (ChBE 415 planned, 3 hours)

Graduation Requirements

Provide a brief narrative description of all graduation requirements, including, but not limited to, credit hour requirements, and, where relevant, requirements for internship, practicum, or clinical. For a graduate program, summarize information about the requirements for completion of the thesis or dissertation, including the thesis committees, and the final defense of the thesis or dissertation. If a thesis or dissertation is not required in a graduate program, explain how the functional equivalent is achieved.

The requirements in total constitute 132 hrs (112 prescribed hrs + 16 hrs for Social Sci + Humanities + 4 hrs Composition). This degree will be offered through Liberal Arts & Sciences, so there are special requirements for general education. Specifically, students must complete the Campus General Education requirements including the campus general education language requirement. General education courses must satisfy the university requirements for social & behavioral sciences, humanities & the arts, and cultural studies (Non-Western, U.S. Minority, and Western Cultures). Courses can count for both the Hum/SS requirements (total 16 hrs) and the campus distribution requirements (Non-Western, U.S. Minority, and Western Cultures). However, students must choose electives with care to satisfy requirements in both areas if they wish to take only the minimum number (16 hrs) of Humanities and SS electives.

Departmental distinction: To graduate with distinction requires a specified minimum grade point average in all Computer Science, Statistics, Information Science, and Mathematics courses listed below. A GPA of 3.25 is required for Distinction, 3.5 for High Distinction, and 3.75 for Highest Distinction.

Specialized Program Accreditation

Describe the institution's plan for seeking specialized accreditation for this program. Indicate if there is no specialized accreditation for this program or if it is not applicable.

We will seek ABET accreditation for the ChemE+DS degree program. Note that ABET accreditation does not require assessments for every course. We will seek accreditation of ChemE+DS mainly based on assessments of the Chemical Engineering components. The core components of the Chemical Engineering degree remain complete in the ChemE+DS proposal and these are already being assessed. The only potential challenge in accreditation will be to gain approval for some +DS core requirements that as "engineering design" electives. We will attempt to justify this designation for CS 307, CS 277, and IS 467. We only need to successfully gain approval for engineering design elective status in one of these courses to meet accreditation requirements. We do not anticipate a need for any assistance from Computer Science, Statistics, Math, or Information Sciences in this effort.

Licensure or Certification for Graduates of the Program

If this program prepares graduates for entry into a career or profession that is regulated by the State of Illinois, describe how it is aligned with or meets licensure, certification, and/or entitlement requirements.

This does not apply to this program.

Plan to Evaluate and Improve the Program

Describe the program's evaluation plan.

Learning objectives and student achievement will be thoroughly assessed as part of the standard engineering accreditation process. Specifically, the proposed degree program will be evaluated for ABET accreditation on three or six-year intervals, like other engineering degrees on campus. ABET sets eight general criteria:

1) Student performance must be monitored and students must be advised regarding career and curriculum matters to ensure graduates attain the program objectives.

2) Program educational objectives must be consistent with the institutional mission, published, and periodically reviewed by an advisory board.

3) Student outcomes required by ABET include a prescribed list of seven abilities including communication, and professional/ethical skills.

4) Continuous improvement must be demonstrated through regular assessment of student outcomes and documented efforts to use assessment findings toward program improvement.

5) Curriculum: ABET sets minimum credit hour requirements on math and basic science, on engineering courses, on broad educational courses, and on capstone design.

6) Faculty members must be of sufficient number and competence to cover all program curricula.

7) Facilities including classrooms, offices, and equipment must be adequate to support student outcomes.

8) Institutional support must be adequate to ensure program quality and continuity.

Chemical and Biomolecular Engineering (ChBE) is an ABET accredited program at the University of Illinois. The ChBE department believes that continued accreditation is important for the long-term success of our program and our graduates. All eight criteria above are already being evaluated by the ChBE department. Institutional support, adequate facilities, qualified faculty, and academic advising/career services are already in place. Quantitative assessments, based on each of the student outcomes and learning objectives are performed once per academic year in each of the core engineering classes. Beyond serving as a step toward accreditation, the assessments are genuinely used to identify areas for program improvement.

Budget Narrative

Fiscal and Personnel Resources

Illinois Administrative Code: 1050.30(a)(5): A) The financial commitments to support the unit of instruction, research or public service are sufficient to ensure that the faculty and staff and support services necessary to offer the unit of instruction, research or public service can be acquired and maintained; B) Projections of revenues necessary to support the unit of instruction, research or public service are based on supportable estimates of state appropriations, local tax support, student tuition and fees, private gifts, and/or governmental grants and contracts.

Budget Rationale

Provide financial data that document the university's capacity to implement and sustain the proposed program and describe the program's sources of funding.

Is the unit's (Department, College, School) current budget adequate to support the program when fully implemented? If new resources are to be provided to the unit to support the program, what will be the source(s) of these funds? Is the program requesting new state funds? (During recent years, no new funds have been available from the state (IBHE) to support new degree programs).

Currently, the CHBE department's budget, faculty and resources have been able to, at its peak enrollment, adequately support 700 students in our program. Our enrollment is currently at 500 students, assuring us that the implementation of this program will not put a strain on any of the program's budgetary resources.

Faculty Resources

Will current faculty be adequate to provide instruction for the new program or will additional faculty need to be hired? If additional hires will be made, please elaborate.

Current faculty will be adequate to provide new instruction for the new program and no new faculty will be needed to implement this program.

Please address the impact on faculty resources including any changes in numbers of faculty, class size, teaching loads, student-faculty ratios, etc.

The formal math requirements in the ChemE+DS degree are essentially the same as those of the ChBE degree. However, beyond the usual ChBE requirements, ChemE+DS will also require rigorous training in statistics, informatics, and programming concepts. These include coursework in statistics, computer science, industrial engineering, the iSchool, and new courses on computational methods and data science specifically for ChBE. Two of the three ChBE electives that will be options for ChemE+DS students have already been offered multiple times. The third course is Data Science for Chemistry and Engineering, which we are planning to offer in Spring of 2024.

Our intent is for the ChemE+DS degree option to make ChBE more competitive in undergraduate student recruiting. We hope the effect is to increase applicant numbers so that we can increase enrollment while also being more selective. Our undergraduate enrollment can increase by as much as 15% without impacting the laboratory courses. The increased enrollments should not affect student to faculty ratio in ChBE. Faculty teaching loads and resources will also be unaffected by the implementation of this new program.

Describe how the unit will support student advising, including job placement and/or admission to advanced studies. Will current staff be adequate to implement and maintain the new program or will additional staff be hired? Will current advising staff be adequate to provide student support and advisement, including job placement and or admission to advanced studies? If additional hires will be made, please elaborate.

We have confirmed with the SCS Advising team (Patricia Simpson and Wolali Dedo) that they can accommodate the additional ChemE+DS students in the current advising model. No additional advising resources are needed.

Are the unit's current facilities adequate to support the program when fully implemented? Will there need to be facility renovation or new construction to house the program?

No new construction or renovation to the CHBE facilities will be needed for the implementation of this program.

Library Resources

Describe your proposal's impact on the University Library's resources, collections, and services. If necessary please consult with the appropriate disciplinary specialist within the University Library.

Current library collections, resources and services are sufficient to support this program.

Summarize information about library resources for the program, including a list of key textbooks, a list of key text and electronic journals that will support this program, and a short summary of general library resources of the University that will be used by the program's faculty, students, and staff.

No library resources will be needed for this course, and none of the courses associated with the +DS have textbooks and will not have use of any particular key texts or electronic journals for support. All of the courses required of this program are already existing (except for CHBE 415, which we are currently submitting for approval and does NOT require a textbook or additional texts/resources), so no new resources are needed.

Are any sources of funding temporary (e.g., grant funding)? If so, how will the program be sustained once these funds are exhausted?

No sources of funding are temporary.

Personnel Budget

Please complete all lines below; all fields are required. For fields where there is no anticipated cost or need, enter 0 or NA.

Category

Year One

Year Five

Notes

Faculty (FTE)

Faculty FTE Year1	Faculty FTE Year 5	Faculty FTE Notes
0	0	NA

Faculty ($)

Faculty Year 1	Faculty Year 5	Faculty Notes
0	0	NA

Advising Staff ($)

Advising Staff Year 1	Advising Staff Year 5	Advising Staff Notes
0	0	NA

Graduate Students ($)

Graduate Students Year 1	Graduate Students Year 5	Graduate Students Notes
0	0	NA

Other Personnel Costs

Other Personnel Costs Year 1	Other Personnel Costs Year 5	Other Personnel Costs Notes
0	0	NA

Facilities and Equipment

Illinois Administrative Code: 1050.30(a)(4): A) Facilities, equipment and instructional resources (e.g., laboratory supplies and equipment, instructional materials, computational equipment) necessary to support high quality academic work in the unit of instruction, research or public service are available and maintained;

B) Clinical sites necessary to meet the objectives of the unit of instruction, research or public service;

C) Library holdings and acquisitions, owned or contracted for by the institution, that are necessary to support high quality instruction and scholarship in the unit of instruction, research and public service, are conveniently available and accessible, and can be maintained.

Describe the facilities and equipment that are available, or that will be available, to develop and maintain high quality in this program. Summarize information about buildings, classrooms, office space, laboratories and equipment, and other instructional technologies for the program.

The CHBE Department consistently maintains a high quality program using our current facilities and equipment. Because the ChemE + DS program will be utilizing the same facilities and equipment, it can be concluded that it, too, will maintain the same high quality seen within the department overall.

Will the program require new or additional facilities or significant improvements to already existing facilities?

No

Will the program need additional technology beyond what is currently available for the unit?

No

Are there other costs associated with implementing the program?

No

Faculty and Staff

Illinois Administrative Code: 1050.30(a)(3): A) The academic preparation and experience of faculty and staff ensure that the objectives of the unit of instruction, research or public service are met; B) The academic preparation and experience of faculty and staff, as evidenced by level of degrees held, professional experience in the field of study and demonstrated knowledge of the field, ensure that they are able to fulfill their academic responsibilities; C) The involvement of faculty in the unit of instruction, research or public service is sufficient to cover the various fields of knowledge encompassed by the unit, to sustain scholarship appropriate to the unit, and to assure curricular continuity and consistency in student evaluation; D) Support personnel, including but not limited to counselors, administrators, clinical supervisors, and technical staff, which are directly assigned to the unit of instruction, research or public service, have the educational background and experience necessary to carry out their assigned responsibilities.

Describe the personnel resources available to develop and maintain a high quality program, including faculty (full- and part-time, current and new), staff (full- and part-time, current and new), and the administrative structure that will be in place to oversee the program. Also include a description of faculty qualifications, the faculty evaluation and reward structure, and student support services that will be provided by faculty and staff.

The formal math requirements in the ChemE+DS degree are essentially the same as those of the ChBE degree. However, beyond the usual ChBE requirements, ChemE+DS will also require rigorous training in statistics, informatics, and programming concepts. These include coursework in statistics, computer science, industrial engineering, the iSchool, and new courses on computational methods and data science specifically for ChBE. Two of the three ChBE electives that will be options for ChemE+DS students have already been offered multiple times. The third course is Data Science for Chemistry and Engineering, which we are planning to offer in Spring of 2024.

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Summarize the major accomplishments of each key faculty member, including research/scholarship, publications, grant awards, honors and awards, etc. Include an abbreviated curriculum vitae or a short description.

Please see attached file for key faculty bios and accomplishments.

Faculty and Staff Attachments

Complete list of Faculty Bios - use for CIM proposal.docx

HLC Section

Credit Hours

Existing or repackaged curricula (Courses from existing inventory of courses):

Number of Credit Hours:

125

Percent of Total:

95

Revised or redesigned curricula (Courses for which content has been revised for the new program):

Number of Credit Hours:

0

Percent of Total:

0

New curricula (Courses developed for the new program that have never been offered):

Number of Credit Hours:

7

Percent of Total:

5

Total Credit Hours of the Program:

Number of Credit Hours:

132

Percent of Total:

100

New Faculty Required

Will new faculty expertise or new faculty members be needed to launch this program?

No

Please explain existing coverage:

No new faculty members will be required to launch this program.

Additional Funds

Will the proposed program require a large outlay of additional funds by the institution?

No

Institutional Funding

Please explain institutional funding for proposed program:

No additional institutional funding is needed for the proposed ChemE + DS program.

EP Documentation

This proposal requires HLC inquiry

No

DMI Documentation

Key: 1204

From: Peters, Baron G
To: chbe-ugprogramoffice
Subject: FW: Bo Li"s Response to course approval for +DS
Date: Tuesday, August 8, 2023 10:50:00 PM

Here is the correspondence with Bo Li.
Cheers,
Baron

From: Li, Bo <libo@illinois.edu>
Sent: Friday, August 4, 2023 3:29 PM
To: Peters, Baron G <baronp@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Douglas, Jeffrey A <jeffdoug@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>
Subject: Re: Bo Li's Response to course approval for +DS

Dear Baron,

Thank you for the additional explanation. The committee recommends including discussion of the CS 101 requirement as part of the justification for omitting STAT 107 from the DS core (include CS 101 as a replacement course on the core list), as it is highly relevant but not emphasized in the original proposal. Would you be able to do that? I think that is all the concern now.

Best,
Bo

From: Peters, Baron G <baronp@illinois.edu>
Date: Friday, August 4, 2023 at 9:06 AM
To: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>, Li, Bo <libo@illinois.edu>, Douglas, Jeffrey A <jeffdoug@illinois.edu>
Cc: Rao, Christopher V <cvrao@illinois.edu>
Subject: RE: Bo Li's Response to course approval for +DS

Dear Professor Li,

Thank you for responding about our ChemE+DS proposal, and for relaying the Committee's concerns about our omission of STAT 107. We hope the Data Science Education Committee might consider an appeal on this matter. Our reasons are briefly summarized below.

You may recall some past correspondences between Professor Jeff Douglas and I about the STAT 107 omission. Our curriculum committee carefully reviewed the STAT 107 syllabus to ensure its content is fully included in the ChemE+DS. In responding to Professor Douglas' concerns, we did not add STAT 107. However, we added ChBE 412 (a python-based numerical methods course), and proposed changes to ChBE 411 (a calculus-based statistics course with

chemical engineering examples). Detailed justifications for these changes were included on page 5 of the proposal.

Your message cites the importance of Python programming in urging us to include STAT 107. ChBE fully appreciates the importance of programming, and more specifically programming in Python. However:

1. CS 101 is a Python based programming course. All engineering majors (including ChBE and ChemE+DS) have to take CS 101.
2. ChBE 412 also focuses on Python programming, with challenging problem sets involving root finding, optimization, numerical integration, differential equation solvers, etc. in the context of chemical engineering problems.

The proposed ChemE+DS curriculum already requires 132 credit hours, so adding STAT 107 will complicate the path to four-year graduation. We recognize that STAT 107 is essential for X+DS programs when the area of specialization ("X") is a non-STEM subject. However, ChemE+DS students students see the STAT 107 content at very early stages in their area of specialization. Because of this, we believe STAT 107 can be omitted with no detrimental effects to their training.

With all due respect, we hope that the Committee might consider this matter soon. We received timely feedback from Professor Douglas and representatives from other departments, but this official response from the Committee has taken a year. The University of Illinois has an opportunity to offer the world's first undergraduate-level ChemE+DS program. We are really excited about this opportunity for our students and for all of the partner departments. However, the proposal needs to be submitted next week to be considered by the LAS curriculum committee this fall. Kathy Thomas-Stagg (cc'd here) will provide the latest version of the proposal in the CIM template for new major proposals. Finally, if possible, please confirm that the Department of Statistics approves the inclusion of STAT 207 in this program, per 8/2/2023 message from Professor Christopher Rao.

Sincerely,
Baron Peters
W. H. and J. G. Lycan Professor
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign
petersgroup.web.illinois.edu
baronp@illinois.edu

From: Li, Bo <libo@illinois.edu>
Sent: Thursday, August 3, 2023 10:41 AM
To: ChBE Department Head <chbe-head@illinois.edu>

Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Re: Course Approvals for Chemical Engineering + Data Science (ChemE + DS) Program

Dear Chris,

I have just heard back from the campus data science education committee. The committee recommended revising the proposal so that ChBE411 is part of the Chem advanced connector courses, not the core, and so that Stat 107 should be included as a first course to be compliant with the college template for X+DS proposals. Stat 107 covers key topics including introduction to Python programming that the students will need.

Thanks,
Bo

From: ChBE Department Head <chbe-head@illinois.edu>
Date: Wednesday, August 2, 2023 at 2:17 PM
To: Li, Bo <libo@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Course Approvals for Chemical Engineering + Data Science (ChemE + DS) Program

Dear Professor Bo Li,

We are writing to formally request your department's support and approval for the inclusion of certain courses in the STAT Department's curriculum as part of the newly proposed Chemical Engineering + Data Science (ChemE + DS) Program within the College of Engineering at the University of Illinois Urbana-Champaign (UIUC).

The ChemE + DS Program is an innovative interdisciplinary program that aims to equip our students with a comprehensive skill set that bridges the gap between traditional chemical engineering and modern data science practices. By integrating key principles from both disciplines, this program will produce graduates who are uniquely prepared to address the complex challenges of our rapidly evolving technological landscape.

To ensure the success and rigor of this program, we are seeking the collaboration of various departments across UIUC. We have identified several courses within your department that align with the objectives of the ChemE + DS Program and would greatly enhance the educational experience of our students. These courses include:

STAT 207	Data Science Exploration

We request your department's approval to allow ChemE + DS students to enroll in these courses and count them toward their program requirements. This collaboration will not only enrich the educational experience of our students but also foster interdisciplinary connections and promote a culture of academic excellence across departments. Your support does NOT guarantee that any

individual course would be offered in any given semester, nor that a position in any course would be guaranteed for a CHBE student in a given semester. If there are any courses in the table you would prefer to exclude from your approval, please make a note of those exclusions in your reply.

Many thanks for your assistance.

Chris Rao
Mentzer Professor
Head, Chemical & Biomolecular Engineering

From: Peters, Baron G
To: chbe-ugprogramoffice; Li, Bo; Douglas, Jeffrey A
Cc: Rao, Christopher V
Subject: RE: Bo Li"s Response to course approval for +DS
Date: Friday, August 4, 2023 9:06:00 AM

Dear Professor Li,

Thank you for responding about our ChemE+DS proposal, and for relaying the Committee's concerns about our omission of STAT 107. We hope the Data Science Education Committee might consider an appeal on this matter. Our reasons are briefly summarized below.

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Baron Peters
W. H. and J. G. Lycan Professor
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign
petersgroup.web.illinois.edu
baronp@illinois.edu

From: Li, Bo <libo@illinois.edu>
Sent: Thursday, August 3, 2023 10:41 AM
To: ChBE Department Head <chbe-head@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Re: Course Approvals for Chemical Engineering + Data Science (ChemE + DS) Program

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Bo

From: ChBE Department Head <chbe-head@illinois.edu>
Date: Wednesday, August 2, 2023 at 2:17 PM
To: Li, Bo <libo@illinois.edu>
Cc: chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>
Subject: Course Approvals for Chemical Engineering + Data Science (ChemE + DS) Program

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To ensure the success and rigor of this program, we are seeking the collaboration of various departments across UIUC. We have identified several courses within your department that align with the objectives of the ChemE + DS Program and would greatly enhance the educational experience of our students. These courses include:

STAT 207	Data Science Exploration

We request your department's approval to allow ChemE + DS students to enroll in these courses and count them toward their program requirements. This collaboration will not only enrich the educational experience of our students but also foster interdisciplinary connections and promote a culture of academic excellence across departments. Your support does NOT guarantee that any individual course would be offered in any given semester, nor that a position in any course would be guaranteed for a CHBE student in a given semester. If there are any courses in the table you would prefer to exclude from your approval, please make a note of those exclusions in your reply.

Many thanks for your assistance.

Chris Rao
Mentzer Professor
Head, Chemical & Biomolecular Engineering

ChBE 411: Chemical Reaction Engineering
Faculty in attendance: Baron Peters (BP), Mary Kraft (MK)
Date of meeting: Sept. 10, 2023

The past and continuing instructors for ChBE 411 met to discuss aspects of this course that worked well, aspects that did not, and to share suggestions for course improvement. The discussion, reflecting today's discussion and written comments from several recent semesters, is summarized below.

1) *What is a minimum set of topics that must be covered each semester – regardless of instructor – to assure the course covers the essentials mandated for this course and prepares students for later courses? As part of this please explicity note specific topics needed for our Capstone courses 430 and 431.*

   Each laboratory station in the ChBE 430 course requires statistical analysis for parameter estimation, uncertainty quantification, and error propagation tasks. Moreover, the students must interpret and integrate their statistical analysis into their written laboratory reports, so they must understand these tools within the chemical engineering context. The ChBE 411 course also provides the probability and statistics foundation for our ChemE+DS students. The minimum essential topics are:

   - Introduction to probability: events, set theory basics, Venn diagrams, Bayes theorem.
   - Combinatorics and counting: combinations, permutations, multinomials.
   - Discrete random variables: Bernoulli trials, geometric, binomial, and Poisson distributions.
   - Means, variances, and expectations.
   - Continuous random variables: densities, cumulative distributions, uniform, exponential, Guassian, power-law, and log-normal distributions.
   - Joint densities and probabilities, correlations, independence, clustering algorithms.
   - Law of large numbers and central limit theorem
   - Statistical inference: parameter estimates and confidence intervals, hypothesis tests, design of experiments, likelihood maximization
   - Linear regression and ANOVA including linearization of models and confidence bands.

2) *How effective has the course been in addressing its goals in recent semesters?*

   Most of the students achieve high marks on exams (averages over 70%) with little need for curved grading. By the end of the course, students are proficient at most aspects of probability, at hypothesis testing procedures, at constructing confidence intervals, and at executing regression and ANOVA procedures. However, the students struggle with design of experiments questions that require them to "work backwards". For example, many students cannot answer questions about the amount of data that will be needed to achieve a target degree of uncertainty. Students also struggle in talking about type I vs. type II errors. Both are signs of conceptual gaps that remain even as students gain proficiency with procedures.

3) *Are there any deficits in student preparedness (from pre-requisites in ChBE, MATH, PHYS, CHEM) that impact successful outcomes for this course?*

Many of the students do struggle with math preparation. Peters gave a math preparation survey at the beginning of the course in 2021. Only 40% of students answered yes to: "Can you sum infinite series and do you recognize the role of dummy variables that vanish vs. parameters that remain in the final summed answer?" Only 26% of students answered yes to: "Have you learned to integrate functions with multiple variables, … change integration order and limits, and introduce a Jacobian to change variables of integration, etc." Peters and Kraft both incorporate brief math recap sessions as needed during lectures.

4) What would you suggest to improve the course in future semesters?

Some TAs lack the required expertise to provide useful and informative office hours sessions. This is partly from the varied degrees to which their undergraduate institutions emphasized probability and statistics training. In some cases, TAs prioritize other duties (research and their own courses) over their TA duties. In the future, Peters and Kraft will encourage their TAs to attend all lectures to ensure they are able to provide instruction.

Kraft and Peters both found that students struggle with the conceptual distinction between random variables, actual average values, and sample estimates. We will give special attention to this foundational aspect of statistics in future classes.

Peters has used low stakes PrairieLearn exercises in class to ensure high attendance. For students who embrace the activity, the PL exercises provide frequent hands-on work and a large library of worked problems to use as study guide. Because these are low stakes in-class exercises, Peters works each problem on the chalkboard with the students who then enter their answers in the PL system. Peters reports that, unfortunately, some students seem to just wait for the answer and put little effort to engage with the process of finding the solutions themselves. He plans to amend this activity by setting up these calculations with the students and then letting them do the calculations. This should incentivize their attention to the setup and require their actual engagement to get correct answers.

Some changes are also required due to the key role of ChBE 411 within the pending ChemE+DS curriculum. ChBE 411 is a calculus-based probability and statistics course that encompasses nearly all topics from Stat 400 and Stat 107. However, the examples, homework, and exams in ChBE411 are built around chemical engineering applications. These include rate parameter estimation from reaction rate data, Poisson statistics problems related to catalyst preparation, survival probability data in nucleation assays, polymer conformations and sequence statistics, regression applied in the context of chemical equilibrium and Van't Hoff analyses, categorical data in characterization of chemically functionalized surfaces, non-parametric tests that arise in particle size distribution data, propagation of uncertainties through relations between fluid flow and transport phenomena, confounding effects in mechanistic studies of catalysis and biochemical processes, etc. A domain-specific training gives our students an opportunity to reinforce their chemical engineering foundations and simultaneously learn probability and statistics in the context of realistic ChBE applications. The specific examples will vary by instructor. However, the domain-specific focus is the primary justification for requiring ChBE 411 in the ChemE+DS degree, as opposed to alternatives taught by industrial engineering and statistics.

To ensure that ChemE+DS students are prepared for later classes, the following changes will be made to future versions of ChBE 411:

- Terminology differences can create language barriers in subsequent data science classes. We will improve the alignment of ChBE 411 with established data science terminology. For example, our students learn experimental designs and hypothesis testing procedures for data that is grouped by strata, but they do not learn that this is called "stratification".
- ChBE 411 does not include an introduction to data clustering algorithms, a key part of many data science applications. We will add a lecture and homework assignment on clustering to ChBE 411 starting in Fall 2023.
- The modern data science profession, even in industrial settings, relies mainly on Microsoft office for simple tasks and python-based computational tools for sophisticated statistical analyses. ChBE 411 instructors will migrate from Minitab and R to Excel and Python in future semesters.

Finally, we note that Kraft and Peters have been the only ChBE 411 instructors for the past four years. Professor Diao will join the ChBE 411 rotation in Fall 2024. We have shared this evaluation with Professor Diao.

Conclusions:

- Need PrairieLearn exercises (even low-stakes questions) to require some independent student work to maintain active student engagement.
- Need to transition from specialized Minitab and R platforms to platforms that are more easily integrated with other functionalities, e.g. Excel and Python software.
- Need to include a lecture on clustering algorithms and ensure that terminology is consistent with that of the data science profession.
- Need to ensure that TAs attend lectures so that they are able to provide effective instruction in office hours.
- Need to work on conceptual design of experiments topics, especially on anticipating the required sample size to achieve a target uncertainty range.
- Need to spend more time on type I vs. type II errors in hypothesis testing and statistical power in experimental designs.

Syllabus ChBE 411 "Probability and Statistics for ChBE"
University of Illinois at Urbana – Champaign
Spring Semester 2023, TR 11:00 am -12:20 pm
Rm. 157 Noyes Laboratory

Credit Hours: 3

Prerequisite: MATH 231

Skills assumed: Algebra (exponentials, logarithms, factorials)
Calculus (derivatives, series, integration, multivariable integration)
Excel. Mathematica or similar symbolic math software.

Instructor: Baron Peters, Rm 292 Roger Adams Lab
office hours: Friday 1-2pm (virtual)
Email: baronp@illinois.edu
please come to office hours for help with assignments

Teaching assistant: Jiankai Ge, jiankai2@illinois.edu
Office hours: Tuesday 4-5pm (virtual)

Course format: Each regular class includes
35-minute lecture
35-minute worksheet session (PrairieLearn) 30%
Reading assignments, practice problems * 0%
*not graded, but they will help you on quizzes
Weekly low-stakes quiz (due Monday 11:59pm) 20%
Five quizzes 50%
In class on last day of weeks 3, 5, 8, 12, 16

Grading Scale: Graded on a curve*, with median grade in the B/B+ range
*the curve can only help you,
i.e. 87% is at least an A-, 77% is at least a B-,
67% is at least a C-, and 57% is at least a D-.

Online platform(s): Canvas (materials, announcements, zoom links)
Zoom (office hours and class when required)
PrairieLearn (worksheets and quizzes)

Text: W. Navidi, *Statistics for Engineering and Scientists*, 5th Edition

Course Description: This course in probability and statistics focuses on common ChBE applications and provides a greater emphasis on probability than traditional statistics courses. Moreover, this course focuses on statistical tests for common ChBE applications. By using examples from chemistry, chemical engineering, and biomolecular engineering, students simultaneously strengthen their foundations in ChBE while learning broadly applicable probability and statistics concepts.

Topics:

1. Axioms, sets, and probabilities [Ch1]
   - Week 1: Events, Inclusion/exclusion, Venn diagrams, DeMorgan Laws
   - Week 2: Bayes theorem and applications
2. Counting/combinatorics [Ch2]
   - Week 3: Combinations, Permutations, Multinomials
   - Quiz #1
3. Discrete random variables [Ch3]
   - Week 4: Bernoulli trials, means, variances, expectations, cumulative dist.
   - Week 5: Geometric, binomial, Poisson distributions
   - Quiz #2
4. Continuous random variables [Ch4]
   - Week 6: Probability measure, intervals, moments, expectations, cumulative dist.
   - Week 7: Uniform, Exponential, Power law, Gaussian, Log-normal distributions
5. Joint distributions [Ch5,6]
   - Week 8: Formulation and calculations
   - Week 8: Descriptive statistics, independence, correlation, and clustering algorithms
   - Quiz #3
6. Central limit theorem [Ch7]
   - Week 9: Law of large numbers and central limit theorem
7. Statistical inference [Ch8 + supplemental notes]
   - Week 9-10: Hypothesis tests
   - Week 11: Parameter estimates and confidence intervals
   - Week 12: Nonparametric tests and design of experiments
   - Quiz #4
8. Linear regression and ANOVA [Ch8 + supplemental notes]
   - Week 13: Assumptions and equations of linear regression
   - Week 14: Linearization of models and heteroscedasticity
   - Week 15: ANOVA, hypothesis tests, confidence envelopes on regression predictions
9. Bayesian statistics and the tools of big data [Ch9 + supplemental notes]
   - Week 16: Likelihood maximization, prior and posterior distributions
   - Quiz #5

Worksheet sessions

Following a preliminary lecture, the instructor will walk students through the solutions to a multi-part exercise in stages. Students should log into PrairieLearn at the beginning of each worksheet session. On PrairieLearn, students will find a worksheet activity. *The necessary concepts should already be familiar to students who have done the suggested reading, the low-stakes quiz, and attended first half of the lecture*. Students will complete the worksheet, submit answers, and receive credit for this activity. However, the professor will be working the problems with them in real time. The worksheets serve several purposes:

i) Promote and motivate your engagement with the material.
ii) Reinforce your independent reading and studying.
iii) Provide guided practice in solving complex problems.
iv) Prepare you to complete the quizzes with no technical difficulties.

Students will earn points for each *correct* worksheet response, so follow along and answer carefully. Each worksheet has equal weight in your grade, with worksheets accounting for a total of 30%. Answers are given, so each worksheet is essentially a participation grade worth ca. 1% of your total grade.

Your ***two*** lowest worksheet grades will be discounted. Be diligent and attend all worksheet sessions that you can. Please do not request exceptions. There are many understandable reasons to miss a class, however you should count these situations among your two discounted scores. Please remember that these are *low stakes assessments* and that credit given for non-participation defeats the purpose. See Article 1, Part 5-Class Attendance in the student Student Code: https://studentcode.illinois.edu/article1/part5/1-501/.

Quiz format:

Quizzes (in class and online) will be much like the worksheets, but students will independently work each problem. In many cases, the quizzes will be broken into multipart questions. In these cases, students must work the problems in sequence. Once an answer two part (a) has been given, it will be assessed and the correct answer will be provided. The student can then move on to question (b). This procedure ensures that students who miss part (a) can start from its correct answer while working part (b), and so on. The ability to "reset" between parts (a), (b), (c), etc. is a unique and objective form of partial credit that is *unique to the online grading system*. Unfortunately, we cannot simultaneously enable traditional (and more subjective) forms of partial credit, e.g. we cannot award credit for correct ideas with flawed algebra. To avoid disappointing results, be careful even in executing the "easy" algebra steps. And remember, the central limit theorem: over five quizzes with multiple parts, your average score almost certainly reflects your actual proficiency and not a stroke of bad luck.

Students are responsible for logging into the PrairieLearn system for quizzes at the appointed time. Makeup quizzes without an approved conflict situations will not be administered. Each in-class quiz is 10% of your final grade, so be diligent, do your best on all of them, and do not miss quizzes.

Student Learning Outcomes:

After this course, students should be able to recognize situations where formal probability theory is applicable, vs. those requiring statistics.

Where applicable, students should be able to formulate probability models, and use them to compute expectations and draw inferences about parameters.

When confronted with data, students should be able to select appropriate statistical procedures to compute confidence intervals, test hypotheses, build regression models, and quantify how uncertainties propagate through procedures and formulas.

Course Commitment: Students are expected to spend six hours per week outside of class reading and performing PrairieLearn exercises. Classroom participation is part of the course grade, assessed through in class PrairieLearn exercises. Students are also strongly encouraged to attend office hours, where the professor typically works additional example problems with students. Note that problems worked in office hours are likely to appear in subsequent exams.

Academic Misconduct:

Students can form groups for reading, lecture viewing, and working practice problems. You may utilize any resource you can find, but *quizzes should be completed without help from others*. To discourage cheating on quizzes and worksheets, inputs/parameters will have randomized numerical values.

The University of Illinois at Urbana-Champaign expects its faculty, staff, students and guests to conduct themselves in accordance with the community values of civility, respect, and honesty; to maintain the highest level of integrity and exercise critical judgment in all dealings, decisions and encounters; and to maintain and strengthen the public's trust and confidence in our institution. Additional text regarding academic integrity expectations can be found at http://admin.illinois.edu/policy/code/index.html, in the University Student Code found and here: https://studentcode.illinois.edu/article1/part4/1-402/.

Academic misconduct (cheating, plagiarism, ….), as a form of fraud, undermines the public trust, both in the institution and in the degree. When you sign your name to work, you are stating that the work is yours, you created it or contributed to it, and you comprehend everything in it. Academic misconduct of any sort will not be tolerated. Instructors are required to report all suspected infractions of academic integrity in the online FAIR system that guides both the instructor and the student through the different phases of the process exactly as stated in the Student Code, including any appeals regarding the finding and/or the sanction.

Anti-Racism and Inclusivity Statement:

The Department of Chemical and Biomolecular Engineering is committed to the creation of an anti-racist, inclusive community that welcomes diversity along a number of dimensions, including, but not limited to, race, ethnicity and national origins, gender and gender identity, sexuality, disability status, class, age, and religious beliefs. The Department recognizes that we are learning together in the midst of the Black Lives Matter movement, that Black, Hispanic, and Indigenous voices and contributions have largely either been excluded from, or not

recognized in, science and engineering, and that both overt racism and micro-aggressions threaten the well-being of our students and our university community.

The effectiveness of this course is dependent upon each of us to create a safe and encouraging learning environment that allows for the open exchange of ideas while also ensuring equitable opportunities and respect for all of us. Everyone is expected to help establish and maintain an environment where students, staff, and faculty can contribute without fear of personal ridicule, or intolerant or offensive language. If you witness or experience racism, discrimination, micro-aggressions, or other offensive behavior, you are encouraged to bring this to the attention of the course instructor (Faculty member, Teach Assistant) if you feel comfortable. You can also report these behaviors to the Bias Assessment and Response Team (BART) (https://bart.illinois.edu/). Based on your report, BART members will follow up and reach out to students to make sure they

have the support they need to be healthy and safe. If the reported behavior also violates university policy, staff in the Office for Student Conflict Resolution may respond as well and will take appropriate action.

Academic Assistance:

Students with disabilities will be appropriately accommodated and should inform the instructor as soon as possible of their needs. Disability Resources and Educational Services (DRES) is located at 1207 South Oak Street; telephone 333-1970; disability@illinois.edu; http://www.disability.illinois.edu. Please inform the instructor of any special accommodation needs at the start of the semester.

Dealing with Stress, Personal Issues:

Counseling services are available to all of our students here on campus. College can be stressful for a variety of reasons. The department of chemical and biomolecular engineering believes your mental health is as important as your physical health and intellectual growth. If you are feeling overwhelmed, depressed, or anxious, there are many resources on campus to assist you. The Counseling Center offers same-day first time appointments, time-limited counseling, long-term group therapy, and several skill development workshops. Please call them at 217-333-3704 to make an appointment, or visit their website, www.counselingcenter.illinois.edu, for more information. If you are experiencing a mental health crisis and feel you are in immediate danger, please call 911. The Champaign County Crisis Line (217-359-4141) is also available 24 hours a day, 7 days a week, 365 days a year.

From:	Miller, Nolan H
To:	Peters, Baron G
Cc:	Downie, Stephen R; Flanagan, Karle Ann; Higdon, Jonathan J L; Newell, Brooke; chbe-ugprogramoffice; Amos, Jenny; Lehman, Barbara J
Subject:	RE: revised ChemE+DS proposal docs, for senate discussion
Date:	Friday, April 19, 2024 1:51:47 PM
Attachments:	image001.png

Dear Baron,

Thanks for this. In deciding how to memorialize this, I think the best way is to attach an email record of what's going on. To that end, the negotiation between Statistics and CHBE to clarify the letter of support from Bo Li that was sent last week identified some minor clarifications that should be incorporated into the CIMP record for this program. These changes are highlighted in yellow below (we extracted the changes from the document you sent earlier). Because they are minor, we don't think we need to hold up the proposal at this point. However, we will not make changes to CIMP unless they go through the governance process. So, if the current proposal is approved you should submit a new program revision to make these changes.

Barb – please add this email to the proposal for ChemE + DS.

Thanks,

Nolan

Program Justification

Provide a brief justification of the program, including highlights of the program objectives, and the careers, occupations, or further educational opportunities for which the program will prepare graduates, when appropriate.

3) Several other courses in the proposed curriculum also reinforce the students' Python programming skills: ChBE 413, Math 257, and CS 307.
ChemE+DS students will also obtain a rigorous training in statistics. They will first encounter statistics as sophomores in ~~STAT 207. Then as juniors, the students will take~~ ChBE 411 (Probability and Statistics for Chemical Engineering) in lieu of STAT 400. ChBE 411 is a calculus-based probability and statistics course. It encompasses nearly all topics from Stat 400 and Stat 107. However, the examples, homework, and exams in ChBE411 are built around chemical engineering applications. These include parameter estimation from reaction rate data, Poisson statistics problems related to catalyst preparation, survival probability data in nucleation assays, polymer conformations and sequence statistics, regression applied in the context of chemical equilibrium and Van't Hoff analyses, categorical data in characterization of chemically functionalized surfaces, non-parametric tests that arise in particle size distribution data, propagation of uncertainties through relations

between fluid flow and transport phenomena, and confounding effects in mechanistic studies of catalysis and biochemical processes. The domain-specific training gives our students an opportunity to reinforce their chemical engineering foundations and simultaneously learn probability and statistics in the context of realistic chemical engineering applications.

Following ChBE 411, students will take STAT 207. There they will use Python, Pandas, Github in statistical analyses and data science workflows, while also building and expanding on the statistics foundations. Note that STAT 207 has a STAT 107 prerequisite, but the statistics department will offer a proficiency exam as an alternative. The exam will assess students' ability to apply basic statistics concepts using python, pandas, and github platforms. In reviewing the Stat 400 and Stat 107 courses, we identified three key additions that will be made to ChBE 411:

• The terminology used in past versions of ChBE 411 was not always aligned with proper terminology as introduced in Stat 107 and Stat 400. For example, our students learn experimental designs and hypothesis testing procedures for data that is grouped by strata, but they do not learn that this is called "stratification". To avoid creation of unnecessary language barriers for our students, we will improve the alignment of ChBE 411 with established data science terminology.

• Previous versions of ChBE 411 did not include an introduction to data clustering algorithms, a key part of many data science applications and a topic that students do see in STAT 107. We added a lecture and homework assignment on clustering algorithms to ChBE 411 in Fall 2023.

- Homework and quizzes in ChBE 411 will be ported to the pandas, python, and github platforms (from Excel, Minitab, and Mathematica in the past). This change will ensure that students arrive to STAT 207 with adequate computational skills on the platforms used in that course. It will also help prepare our students for the STAT 207 proficiency exam.

General Education Requirements

Follows the campus General Education (Gen Ed) requirements. Some Gen Ed requirements may be met by courses required and/or electives in the program.

Course List

Code	Title	Hours
Composition I		4-6
Advanced Composition		3
fulfilled byCHBE 431		
Humanities & the Arts (6 hours)		6
Natural Sciences & Technology (6 hours)		6
fulfilled byCHEM 202&CHEM 204orCHEM 102&CHEM 104;PHYS 211,PHYS 212		
Social & Behavioral Sciences (6 hours)		6
Cultural Studies: Non-Western Cultures (1 course)		3
Cultural Studies: US Minority Cultures (1 course)		3
Cultural Studies: Western/Comparative Cultures (1 course)		3

Quantitative Reasoning (2 courses, at least one course must be Quantitative Reasoning I) fulfilled byCS 101,MATH 221orMATH 220,MATH 231,MATH 241,PHYS 211,PHYS 212,STAT 207	6-10
Language Requirement (Completion of the third semester or equivalent of a language other than English is required)	0-15

Data Science Core

Mathematical Foundations

Course List

Code	Title	Hours
MATH 221	Calculus I	4
or MATH 220	Calculus	
MATH 231	Calculus II	3
MATH 241	Calculus III	4
MATH 257	Linear Algebra with Computational Applications	3
MATH 285	Intro Differential Equations	3
or MATH 441	Differential Equations	
Total Hours		17

Data Science Fundamentals

Course List

Code	Title	Hours
CHBE 411	Probability and Statistics for ChBE	3
STAT 207	Data Science Exploration (must pass proficiency exam to enroll)	4
CS 307	Modeling and Learning in Data Science	4
or CHBE 413	Data Science for Chemistry and Engineering	
IS 477	Data Management, Curation & Reproducibility	3
Total Hours		14

Growth

Describe how the proposed program will expand access and opportunities for students through high-impact practices including research opportunities, internships, apprenticeships, career pathways, and other field experiences.

8H. An example at DPI is the City Scholars program, which pairs top engineering students with Chicago tech companies for semester-long internships. Engineering City Scholars work 20 hours per week at a paid internship with Chicago tech companies, making connections and building a competitive career-focused resume.

As noted in the previous response, the Research Park expands access and opportunities for students by employing 800 interns year-round in part-time research opportunities and career-relevant internships, allowing University of Illinois Urbana-Champaign undergraduate and graduate students to work on campus and be enrolled as full-time students.

In an effort to establish or enhance sustainable outreach and partnerships with PreK-12 schools, the Chancellor at the University of Illinois Urbana-Champaign established the position of Associate Chancellor for PreK-12 Initiatives in August 2021. This new position creates partnerships with superintendents statewide as well as identifies and partners with key education stakeholders to attract and retain undeserved and underrepresented students. It allows us to rethink and enhance the high school to college pipeline in Illinois by partnering with organizations such as Chicago Scholars, Hope Chicago, the Discovery Partners Institute (DPI), Illinois Innovation Network (IIN), and the Jackie Joyner-Kersee Foundation. Hope Chicago, for example, works with Chicago Public School graduates to ensure they have the financial and wraparound supports necessary to be successful in obtaining a degree by providing a student success program, career services, alumni outreach, and program performance goals.

This new initiative reconceptualizes the important role higher education must play in ensuring Illinois learners gain the confidence and comprehension for college. The ultimate goal of this initiative is to ensure that the University of Illinois Urbana-Champaign has developed structural outreach and partnerships to systemically close persisting opportunity gaps in our state's school systems.

The Office of Undergraduate Research (OUR) is guided by the philosophy that all Illinois undergraduate students should learn about current disciplinary research, take part in research discussions, and be exposed to research experiences in their regular coursework. Furthermore, where practical, an advanced research experience should be among the capstone options in all major programs of study. Undergraduate research opportunities should be designed to support the pedagogical goals and the research mission of the university. To achieve its mission, OUR seeks to: 1) inspire students and faculty to collaborate on research projects driven by mutual interests by fostering a research mentoring environment that encourages and rewards collaboration; 2) disseminate best practices and models for undergraduate research to campus stakeholders; 3) assist in the development and evaluation of curricular and co-curricular structures that support undergraduate research; 4) encourage the creation of new opportunities for undergraduate research on campus and 5) coordinate and nurture undergraduate research efforts across academic units on campus.

College, department, and program level high-impact practices

The data science experience component of the proposal ensures that our graduates will have hands on data science experience at the time of graduation. The practicum course, ChBE 415, gives students an opportunity to apply their data science training and chemical engineering foundations, to draw conclusions from data analysis, and document their results and findings. Although some students may opt to complete this course through undergraduate research, many of our students do industrial internships.

Students in ChemE+DS will have a complete training in Chemical Engineering, but they will also be eligible for a host of new employment and internship opportunities because of their data science training. The new opportunities include entirely new companies, e.g. they will be particularly suited to work with companies that specialize in financial, safety, and logistics aspects of the chemicals industry. The new opportunities also include data science components of the traditional chemical engineering sector, including aspects of technology development, process design, and process control.

ILLINOIS

NOLAN H MILLER

Daniel and Cynthia Mah Helle Professor in Finance | Department of Finance
Chair, Senate Committee on Education Policy
Director, Center for Business and Public Policy
Gies College of Business | University of Illinois at Urbana-Champaign
217.244.2847 | nmiller@illinois.edu | http://www.business.illinois.edu/nmiller

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From: Peters, Baron G <baronp@illinois.edu>
Sent: Friday, April 19, 2024 10:59 AM
To: Miller, Nolan H <nmiller@illinois.edu>
Cc: Downie, Stephen R <sdownie@illinois.edu>; Flanagan, Karle Ann <kflan@illinois.edu>; Higdon, Jonathan J L <jhigdon@illinois.edu>; Newell, Brooke <bsnewell@illinois.edu>; chbe-ugprogramoffice <chbe-ugprogramoffice@illinois.edu>; Amos, Jenny <jamos@illinois.edu>
Subject: revised ChemE+DS proposal docs, for senate discussion

Dear Everyone,
I apologize for yet another computing error. Clearly I am ready to run a ChemE+DS program . This time, I promise that the correct document is attached.
Sincerely,
Baron Peters
W. H. and J. G. Lycan Professor
Director of Undergraduate Studies
Chemical and Biomolecular Engineering
University of Illinois at Urbana-Champaign
https://petersgroup.web.illinois.edu/
rare events and reaction rate theory (book)
baronp@illinois.edu

805-284-8293