THE OHIO STATE UNIVERSITY

College of Engineering

Undergraduate Education & Student Services

122 Hitchcock Hall
2070 Neil Avenue
Columbus, OH 43210-1278

614-292-2651 Phone
614-292-9379 Fax

engineering.osu.edu

Memo

To: Randy Smith, Vice Provost for Academic Programs, Office of Academic Affairs
From: Rosie Quinzon-Bonello, Assistant Dean for Curriculum and Assessment
Date: October 5, 2021

Re: Program Changes to the Chemical and Biomolecular Engineering BS Program

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On October 1, 2021 the College of Engineering Committee on Academic Affairs unanimously approved the following program changes to the Chemical and Biomolecular Engineering BS Program:

1. a reduction in the total credit hours for students to graduate from 132 to 127
2. a reduction of course credit hours from four to three in core chemical engineering courses, and
3. course additions to meet future perceived student needs

Attached is the proposal that provides details and documentation. Please feel free to contact me should you have additional questions.

Yours sincerely,

Rosie Quinzon-Bonello

Cover Letter

Friday, November 12, 2021

Professor Rebecca Dupaix

Chair of the College Committee for Academic Affairs

Dear Professor Rebecca Dupaix,

We are writing to request that the Committee for Academic Affairs considers the proposed changes to the curriculum for the Department of Chemical and Biomolecular Engineering. The proposed changes include (1) a reduction in the total credit hours for students to graduate from 132 to 127; (2) modification of the course credit hours from four to three for core chemical engineering courses; and (3) addition of courses to meet future perceived student needs. The proposed changes were discussed during a series of faculty meetings before a final vote was recorded to approve the proposed changes with unanimous consent by the faculty (18 votes recorded during the meeting; 4 additional votes for support received via email).

The proposed modifications can be organized into three categories: (1) additions; (2) modifications; and (3) elimination. We propose the addition of three courses, including: (1a) Chemical Engineering Seminar (1 credit hour); (1b) Computational Methods for Chemical Engineers; and (1c) Process Safety (2 credit hours). For these new courses, we are including a proposed syllabus.

We propose a range of modifications, including:

(2a) reducing the following courses from four to three credit hours (i) CBE 2200; (ii) CBE 3610; (iii) CBE 4760; and (iv) CBE 4764;

(2b) modifying CBE 3508 (currently one course that is 4 credit hours) into two courses CBE 3508 and CBE 3509 (two courses that will be 3 credit hours each)

(2c) modifying the Unit Operations course sequence (CBE 3631 and CBE 3632 (currently 2 credit hours each) into a three course sequence (CBE 3730 (1 credit hour), CBE 3731 (1 credit hour), and CBE 3732 (2 credit hours))

(2d) modifying the pre-requirement for CBE 2200 of admission to the major before a student can take CBE 2200

(2e) modifying the math requirement from Math 2177 to Math 2173

(2f) modifying the math/statistics requirement to include CBE 5779

(2g) modifying the transport sequence from two courses that are each 4 credit hours to 3 courses that are each 3 credit hours

The modified syllabi for these courses are included.

We are also proposing the elimination of two courses from the core requirements, including Biology 1113 and Physics 1251. [These academic units have been notified; see attached emails.]

Overall, these proposed modifications will provide more flexibility for the students in scheduling courses than the current curriculum, provide a range of courses that cover topics that are relevant to future skill, and reduce the requirements for graduation.

If there are any questions, please let us know.

Sincerely,

Nicholas A. Brunelli

Chair of the Curriculum Working Group for Chemical and Biomolecular Engineering

Update 1:

As discussed with the chair of College Council on Academic Affairs (CCAA) Rebecca Dupaix and the sub-committee chair Carolyn Sommerich, we are updating the proposal to include points (1c), (2aiii), and (2aiv). In January 2021, these changes were submitted as course change proposal rather than a curriculum change proposal. The intention was to submit these changes as a curriculum change proposal. Currently, the course change proposals have been entered into the system and are pending the approval of the curriculum change proposal.

Update 2 (2021 11 12):

The proposal was modified to account for the new general education (GE) requirements for the degree. The updates included adding the GE launch seminar and modifying the credit hours of the final GE courses.

(1a) Proposed change: Addition of course – Computational Methods for Chemical Engineers – 3 credit hours (CBE 2345)

Rationale: The proposed addition of a course is to meet a future skill demand. As engineering problems become more complex, a solid basis in computational methods will become increasingly in demand. This course was checked for concurrence by faculty in Mechanical Engineering and Computer Science and Engineering. Since this course did not have sufficient overlap, the course was offered as a technical elective in Spring 2021. Comments in the SEIs indicated that “every Chem should be required to take this class,” “I hope they make this class a staple in the department

because it's a set of skills every ChemE should have," and "I hope that this course is offered regularly in the future as it has been hugely beneficial." These positive comments contributed to our decision to add the course as a core requirement. Finally, peer institutions have implemented a course that was used as a basis for designing the new course.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(1b) Proposed change: Addition of course – Chemical Engineering Seminar – 1 credit hour (CBE 2100)

Rationale: The proposed addition of a course is to address several important topics, including diversity, teamwork, and an overview of the profession. The course is being designed based on peer institutions. At the same time, this course was previously included in the curriculum when operating under the quarter system. The course will address challenges with diversity, equity, and inclusion as well as future career opportunities for chemical engineers.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(1c) Proposed change: Addition of course – Process Safety – 2 credit hours (CBE 4755)

Rationale: Process safety is critical to the chemical industry. Chemical and Biomolecular Engineering does not currently have a course strictly focused on this topic, although it had one in the past. Rather, process safety has been addressed in a number of courses, particularly in the senior design sequence CBE 4760 and 4764. A course strictly focused on process safety will enable students to engage the subject in a more holistic manner and at a higher level. Our alumni advisory board has strongly endorsed this effort, and several members provided additional advice that has helped shape the proposed process safety course. Since we do not wish to burden our students with additional course credit requirements, we are reducing the credit load of the senior design coursed to conserve total credit hours. This change also means that students will have the flexibility to take the process safety course earlier in the curriculum, or in parallel with the CBE 4760 and 4764 courses.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2ai) **Proposed change:** Modification of course – CBE 3610 – Kinetics and Reactor Design – Current – 4 credit hours; Proposed – 3 credit hours

Rationale: The proposed reduction in credit hours will be part of the effort to make all core courses three credit hours. Originally, this course was taught with a set of core concepts. During the transition from quarters to semesters, some of the content from the Thermodynamics course was shifted into this course. The content from the Thermodynamics course will be returned to the

Thermodynamics course. Additional reduction in content will reduce the time required to teach the course to three credit hours.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2aii) **Proposed change:** Modification of course – CBE 2200 – Process Fundamentals – Current – 4 credit hours; Proposed – 3 credit hours

Rationale: The proposed reduction in credit hours will be part of the effort to make all core courses three credit hours. There will be a reduction in content associated with transient balances. The resulting content will be included in subsequent courses such as CBE 3521.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

Update (2aiii) **Proposed change:** Modification of course – CBE 4760 – Process Design, Economics, and – Current – 4 credit hours; Proposed – 3 credit hours

Rationale: The proposed reduction in credit hours will be part of the effort to make all core courses three credit hours. The reduction in credit hours will be achieved through moving content associated with process safety to a separate Process Safety course (see 1c).

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

Update (2aiv) **Proposed change:** Modification of course – CBE 4764 – Senior Design – Current – 4 credit hours; Proposed – 3 credit hours

Rationale: The proposed reduction in credit hours will be part of the effort to make all core courses three credit hours. The reduction in credit hours will be achieved through moving content associated with process safety to a separate Process Safety course (see 1c).

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2b) **Proposed change:** Modification of course – CBE 3508 – Thermodynamics – Current – 4 credit hours; Proposed – two courses that are each 3 credit hours

Rationale: The proposed modification to the Thermodynamics course will be part of the effort to make all core courses three credit hours. When moving from quarters to semesters, the proposed Thermodynamics curriculum was being reduced from two courses to one single course. The current single course offering moves rapidly to cover the required content. Additionally, content that was traditionally taught in Thermodynamics was moved to the Kinetics and reactor design course. Whereas this solution has been workable, the instructors for the Thermodynamics courses

have indicated that a second course would be desirable. The second course would enable more discussion on multi-component thermodynamics and the application of thermodynamics to relevant chemical systems.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2c) **Proposed change:** Modification of course – CBE 3631 – Unit Operations – Current – 2 credit hours; Proposed – two courses that are each 1 credit hour

Rationale: The proposed modification to the Unit Operations course sequence will be to modify one of the required Unit Operation courses (CBE 3631; 2 credit hours) while maintaining the second required Unit Operation course (CBE 3732; 2 credit hours). For CBE 3631, the course will be split into two courses (CBE 3730 and CBE 3731) that are each one credit hour. CBE 3730 will be a requirement that is taken alongside of the Kinetics course (CBE 3610). CBE 3630 will have experiments relevant to CBE 3610, integrating experimental measurements and classroom discussion. The integration is proposed as a method to improve student learning and retention.

The second one credit hour Unit Operations course (CBE 3731) would be associated with the transport sequence. Integrating the lab and classroom experiences are projected to have a beneficial learning outcome.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2d) **Proposed change:** Modification of course – CBE 2200 – Process Fundamentals – Remove the pre-requirement that students are admitted to the major before they can take the course.

Rationale: Students have the required math skills that s/he will need to be successful in CBE 2200. At the same time, CBE 2200 is often the course that employers want undergraduates to have completed before s/he receives an internship experience. Allowing students to take CBE 2200 in the freshman year makes it possible for students to find internship opportunities earlier that are often associated with student success in finding full-time employment post-graduation. Additionally, it will be beneficial for students that are considering Chemical Engineering as a major since students will have earlier exposure to the basic content that will be taught in more depth later in the curriculum.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2f) **Proposed change:** Modification of course pre-requirement for Chem 4300

Rationale: The current pre-requirement for Chem 4300 includes Physics 1251. As Physics 1251 is being eliminated as a requirement (see below), it will be necessary to modify the pre-requirement for Chem 4300. The modification has been discussed with the Chemistry department with content related to Kinetics (currently taught in CBE) being the topic that will be removed.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2g) **Proposed change:** Modification of required course – Math 2177 will be replaced by Math 2173.

Rationale: The modification of the math requirement is an effort to reduce the overall number of credit hours as well as to use a course that focuses on ordinary different equations. Content from Math 2177 that is not in Math 2173 consists of linear algebra and partial differential equations (PDEs). Linear algebra concepts will be taught in a new Chemical Engineering course (see 1a). PDEs will be taught in the second Transport course.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2h) **Proposed change:** Modification of course requirements to include CBE 5779 as an option to fulfill the math/stats technical elective.

Rationale: The current math/stats technical elective can be satisfied by: Math 2568, 4512, 4551, 4552, 5000 to 5999 (except 5194) or Stats 3450, 3460, 3470, 4201, 4202. In the current CBE curriculum, we offer CBE 5779 as a technical elective. This course covers many statistic concepts and teaches students to use the program JMP. From discussions with students, CBE 5779 provides similar content to the Stats technical elective. Additionally, CBE 5779 is a very popular course with approximately 80% of the students completing this course. The inclusion of CBE 5779 in the list of potential technical electives will reflect the reality that CBE 5779 involves appropriate concepts to serve as the math/stats elective.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(2i) **Proposed change:** Modification of Transport course sequence from CBE 2420 and CBE 3521 (both are four credit hour courses) to a three course sequence with each course being three credit hours.

Rationale: The current Transport sequence has three core concepts (momentum, heat, and mass). Currently, we are teaching two courses (1) momentum with some heat transfer topics; and (2) some

additional heat transfer topics combined with mass transfer. We think that teaching each topic as a separate course will be beneficial. Additionally, the separate courses will provide instructional time to include additional content related to energy transfer (e.g., solar cells) and mass transfer (e.g., electrochemical processes in batteries).

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(3a) **Proposed change:** Elimination of Bio 1113 as a core course requirement.

Rationale: During the switch from quarters to semesters, the faculty decided to require a course in Quantitative Biology. This course was developed, but students indicated that the course had too much content. The requirement was modified so that students could take Bio 1113. Largely, this course has not served the original intended purpose as more than 50% of our CBE students test out of this course through EM. Additionally, the course was suggested to be taken during the senior year. Since students took this course rather late in the curriculum, students that became interested in the area of Biology (or Biomolecular content) did not have sufficient remaining flexibility in her/his schedule to include additional courses relevant to Biology. These reasons have caused us to propose the removal of Bio 1113 as a required course. Instead, students will be educated about the potential for including more Biology coursework through the inclusion of content related to biology and through a class during the seminar course (see 1b).

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

(3b) **Proposed change:** Elimination of Physics 1251 as a core course requirement.

Rationale: We are proposing the elimination of Physics 1251 from the core course requirement since the primary purpose of the course for CBE students is to complete the course as a pre-req for Chemistry 4300. It is believed that eliminating Physics 1251 will help to reduce the overall credit hour requirements and the required content can be included in the modified version of Chem 4300.

Present curriculum: See attached BINGO sheets.

Syllabus for new course: See attached.

1. Process Fundamentals (CBE 2200) – reducing 1 credit hour
    b. Students that have complete CBE 2200
        1. No additional requirement
    c. Students that have not completed CBE 2200
        1. Students take CBE 2200 and seminar course (CBE 2100) (see point 2)

2. Chemical Engineering Seminar (CBE 2100) – adding 1 credit hour
    b. Students completing CBE 2200 (4 credit hours) will not have to complete seminar

3. Transport Sequence – adding 1 credit hour
    b. Students with no transport – require to complete 3 course sequence (+1 credit hour)
        1. Offset by Physics 1251 or Biology 1113
    c. Students with CBE 2420 – require to complete 2 course sequence (+2 credit hours)
        1. Offset by Physics 1251 or Biology 1113
    d. Students with CBE 2420/CBE 3521
        1. No additional requirements

4. Thermodynamics Sequence (CBE 3508 and CBE 3509) – adding 2 credit hours
    b. Students with Thermodynamics – no additional credits
    c. Students without Thermodynamics – 2 additional credit hours
        1. Offset with Physics 1251

5. Computational Methods for Chemical Engineers (CBE 2345)
    b. Students completing Physics 1251/Math 2177 (math course is more important)
        1. Not required
    c. Students before Physics 1251/Math 2177
        1. Required to take

6. Unit Ops (CBE 3730, CBE 3731, CBE 3732)
    b. Students with both Unit Ops (CBE 3631/3632)
        1. No additional requirement
    c. Students with 1 Unit Ops (CBE 3631)
        1. Complete CBE 3732
    d. Students with no Unit Ops
        1. Complete 3730, 3731, 3732

7. Kinetics (CBE 3610 – 4 credit hours)
    b. Students with CBE 3610 complete
        1. No additional requirements
    c. Student without CBE 3610 complete
        1. Complete CBE 3610 (3 CH)

8. Process Safety (CBE 4755 – 2 credit hours)
    b. Students with CBE 4760, CBE 4764 complete
        1. No additional requirements
    c. Students with CBE 4760 complete
        1. Complete CBE 4764 (3 credit hours)
    d. Students without CBE 4760, CBE 4764
        1. Complete CBE 4760, CBE 4764, CBE 4755

Current Curriculum

Yellow – Unit Ops – first course (2 credit hours) is split into two courses (1 credit hour each); no change in total
Green – reduction from 4 to 3 credit hours
Gray – combined Transport sequence (2 courses that are 4 credit hours each) that will be split into three courses that are each 3 credit hours
Red – Thermodynamics courses (currently 1 course that is 4 credit hours) that will be split into two courses that are each 3 credit hours
Cyan – courses that will be eliminated
Magenta – course that will have CBE 5779 added as a potential course to satisfy requirement
Dark Green - Two additional courses will be added, including computational methods for chemical engineers and seminar

Suggested Curriculum

This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn	Spring
1	___ CHEM 1210 *(Gen Chem I)* ..... 5 hr ___ MATH 1151 *(Calculus I)* ..... 5 hr ___ ENGR 1181.xx *(Fundamentals of ENGR I)* ..... 2 hr ___ ENGR 1100.15 *(Engineering Survey)* ..... 1 hr ___ General Education ..... 3 hr	___ CHEM 1220 *(Gen Chem II)* ..... 5 hr ___ MATH 1172 *(Engineering Math A)* ..... 5 hr ___ ENGR 1182.xx *(Fundamentals of ENGR II)* ..... 2 hr ___ Engr 1221 or CSE 1222*(Programming)* ..... 2-3 hr ___ General Education ..... 3 hr
2	___ CHEM 2510 *(Organic Chemistry I)* ..... 4 hr ___ CBE 2200 *(Process Fundamentals)* ..... 4 hr ___ MATH 2177 *(Mathematical Topics for Engineers)* 4 hr ___ PHYSICS 1250 *(Mechanics, Thermal, Waves)* ..... 5 hr	___ CHEM 2520 *(Organic Chemistry II)* ..... 4 hr ___ CBE 2420 *(Transport Phenomena 1)* ..... 4 hr ___ CBE 2523 *(Separation Processes)* ..... 3 hr ___ PHYSICS 1251 *(E&M, Optics, Modern Phys)* ..... 5 hr
3	___ CHEM 4300 *(Physical Chemistry I)* ..... 3 hr ___ CBE 3508 *(Thermodynamics)* ..... 4 hr ___ CBE 3521 *(Transport Phenomena II)* ..... 4 hr ___ Math or Stats Technical Elective ..... 3 hr ___ General Education ..... 3 hr	___ CHEM 2540 *(Organic Chemistry Lab I)* ..... 2 hr ___ CBE 3610 (*Kinetics and Reactor Design)* ..... 4 hr ___ CBE 3631 *(Unit Operations Lab I)* ..... 2 hr ___ Technical Elective ..... 3 hr ___ General Education ..... 3 hr ___General Education ..... 3 hr
4	___ CBE 3632*(Unit Operations Lab II)* ..... 2 hr ___ CBE 4760 *(Process Design, Econ, & Strategy)* ..... 4 hr ___ CBE 4764 *(Process Sim & Product Eng)* ..... 4 hr ___ BIOLOGY 1113 *(Energy Transfer & Develop)* .....4 hr ___ General Education ..... 3 hr	___ CBE 4624 *(Process Dynamics and Control)* ..... 3 hr ___ Technical Elective ..... 3 hr ___ Technical Elective ..... 3 hr ___ General Education ..... 3 hr ___ General Education ..... 3 hr

Total Hours to complete the degree program = 132-133

Proposed Curriculum – Option 1

Yellow – Unit Ops – first course (2 credit hours) is split into two courses (1 credit hour each); no change in total
Green – reduction from 4 to 3 credit hours
Gray – combined Transport sequence (2 courses that are 4 credit hours each) that will be split into three courses that are each 3 credit hours
Red – Thermodynamics courses (currently 1 course that is 4 credit hours) that will be split into two courses that are each 3 credit hours
Cyan – courses that will be eliminated
Magenta – course that will have CBE 5779 added as a potential course to satisfy requirement
Dark Green - Two additional courses will be added, including computational methods for chemical engineers and seminar

Suggested Curriculum
This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn	Spring
1	___ CHEM 1210 *(Gen Chem I)* 5 hr ___ MATH 1151 *(Calculus I)* 5 hr ___ ENGR 1181.xx *(Fundamentals of ENGR I)* 2 hr ___ ENGR 1100.15 *(Engineering Survey)* 1hr ___ GE *(Launch Seminar)* 1 hr ___ GE *(Writing and Information Literacy)* 3 hr 17	___ CHEM 1220 *(Gen Chem II)* 5 hr ___ MATH 1172 *(Engineering Math A)* 5 hr ___ ENGR 1182.xx *(Fundamentals of ENGR II)* 2 hr ___ Engr 1221 2 hr ___ CBE 2200 *(Process Fundamentals)* 3 hr 17
2	___ CHEM 2510 *(Organic Chemistry I)* 4 hr ___ GE *(Literary, Visual, and Performing Arts)* 3 hr ___ MATH 2173 *(Mathematical Topics for Engineers)* 3 hr ___ CBE 3508 *(Thermodynamics 1)* 3 hr ___ CBE 2523 – *(Separations)* 3 hr ___ CBE 2100 *(Chemical Engineering Seminar)* 1 hr 17	___ CHEM 2520 *(Organic Chemistry II) OR Mol Gen 3300 OR Biochem 4511* 4 hr ___ CBE 2420 *(Transport Phenomena 1)* 3 hr ___ CBE 3509 *(Thermodynamics 2)* 3 hr ___ CBE 2345 *(Computational Methods for ChE)* 3 hr ___ CHEM 2540 *(Organic Chemistry Lab I)* 2 hr 15
3	___ PHYSICS 1250 *(Mechanics, Thermal, Waves))* 5 hr ___ GE *(Historical and Cultural Studies)* 3 hr ___ CBE 3421 *(Transport Phenomena 2)* 3 hr ___ CBE 3730 *(Unit Operations Lab I)* 1 hr ___ CBE 5779 *(Design and Analysis of Experiments)* 3 hr 15	___ CBE 3610 *(Kinetics and Reactor Design)* 3 hr ___ CBE 3422 *(Transport Phenomena 3)* 3 hr ___ CBE 3731 *(Unit Operations Lab II)* 1 hr ___ Technical Elective 3 hr ___ Chem 4300 *(Physical Chemistry)* 3 hr ___ GE *(Social & Behavioral Sciences)* 3 hr 16
4	___ CBE 3732*(Unit Operations Lab)* 2 hr ___ CBE 4760 *(Process Design, Econ, & Strategy)* 3 hr ___ CBE 4755 *(Process Safety)* 2 hr ___ CBE 4624 *(Process Control)* 3 hr ___GE *(Race, Ethnic, & Gender Diversity)* 3 hr ___ GE *(Citizenship for a Diverse & Just World)* 4 hr 17	___ CBE 4764 *(Senior Design)* 3 hr ___ Technical Elective 3 hr ___ Technical Elective 3 hr ___ GE *(Student Choice)* 4 hr 13

Total Hours to complete the degree program = 127

Program Options
Students wishing to complete the biomolecular focus will substitute Biochemistry 4511 in place of Chemistry 2520.

Acceptance Criteria
Acceptance into this program is based on the eligibility point hour ratio (EPHR) of Math 1151, 1172; Engineering 1181.xx, 1182.xx; and Chemistry 1210, 1220. A 3.2 EPHR guarantees admission during the academic year but admission is more competitive in autumn semester. Applications are accepted during autumn and spring term.

Technical and Other Electives

Students have the option to complete a biomolecular, environmental, or polymer focus for their technical elective plan. Each focus will require the completion of two approved courses in CBE plus one additional course in CBE or in another department. All students will also be required to complete one math or statistics technical elective.

____CBE XXXX…….....(3 hr)

____CBE XXXX…….....(3 hr)

____Math/Stat XXXX/CBE 5779…….(2-4 hr)

____Additional Course XXXX …..(2-4 hr)

____**Total Hours (minimum of 12 are required)**

General Education Requirement

Writing and Communication

English 1110.xx 3 hr

Second Writing Course 3 hr

Social Science

Only one course per Social Science group may count.

3 hr

3 hr

Literature

3 hr

Visual and Performing Arts

3 hr

Historical Study

3 hr

Second Historical Study or Cultures and Ideas

3 hr

Social Diversity in the United States

Some courses may overlap with another GE category, See course list.

0 / 3 hr

Ethics

Some courses may overlap with another GE category, See course list.

0 / 3 hr

Foreign Language

Pre-approved substitutions

A. Credit (including EM) for a foreign language sequence through 1103, or credit for a foreign language course with a prerequisite of 1103, can be substituted for one Gen Ed course requirement as a Cultures & Ideas.
B. Completion of a foreign language minor can be substituted for two Gen Ed courses: one course as a Social Science, (Individuals & Groups or Organizations & Polities subgroups only) and one course as either a Literature or a Cultures & Ideas.

Parameters: Students must choose either Substitution A OR Substitution B. Both substitutions cannot be applied simultaneously.

University Capstone (Cross-Disciplinary Seminar)

Pre-approved substitutions

Completion of a Social Science 3597 or 4597 can be substituted for a Social Science general education course in any group. Completion of an Arts & Humanities 3597 or 4597 can be substituted for a Visual/Performing Arts general education course.

See the list of approved general education courses for additional details: www.advising.engineering.osu.edu.

Proposed Curriculum – Option 2

Yellow – Unit Ops – first course (2 credit hours) is split into two courses (1 credit hour each); no change in total
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3	___ PHYSICS 1250 *(Mechanics, Thermal, Waves))* 5 hr ___ GE *(Historical & Cultural Studies)* 3 hr ___ CBE 5779 *(Design and Analysis of Experiments)* 3 hr ___ CBE 2420 *(Transport Phenomena 1)* 3 hr ___ CBE 3509 *(Thermodynamics 2)* 3 hr 17	___ CBE 3610 *(Kinetics and Reactor Design)* 3 hr ___ Technical Elective 3 hr ___ Technical Elective 3 hr ___ CBE 3421 *(Transport Phenomena 2)* 3 hr ___ CBE 3730 *(Unit Operations Lab I)* 1 hr 13
4	___ CBE 4760 *(Process Design, Econ, & Strategy)* 3 hr ___ GE *(Citizenship for a Diverse & Just World)* 4 hr ___ CBE 3422 *(Transport Phenomena 3)* 3 hr ___ P-Chem 4300 3 hr ___ CBE 3731 *(Unit Operations Lab II)* 1 hr 17	___ CBE 4764 *(Senior Design)* 3 hr ___ Technical Elective 3 hr ___ GE *(Student Choice)* 4 hr ___ CBE 4624 *(Process Control)* 3 hr ___ CBE 4755 *(Process Safety)* 2 hr ___ CBE 3732*(Unit Operations Lab III)* 2 hr 17

Total Hours to complete the degree program = 127

Program Options
Students wishing to complete the biomolecular focus will substitute Biochemistry 4511 in place of Chemistry 2520.

Acceptance Criteria
Acceptance into this program is based on the eligibility point hour ratio (EPHR) of Math 1151, 1172; Engineering 1181.xx, 1182.xx; and Chemistry 1210, 1220. A 3.2 EPHR guarantees admission during the academic year but admission is more competitive in autumn semester. Applications are accepted during autumn and spring term.

Technical and Other Electives

Students have the option to complete a biomolecular, environmental, or polymer focus for their technical elective plan. Each focus will require the completion of two approved courses in CBE plus one additional course in CBE or in another department. All students will also be required to complete one math or statistics technical elective.

____CBE XXXX…….....(3 hr)

____CBE XXXX…….....(3 hr)

____Math/Stat XXXX/CBE 5779…….(2-4 hr)

____Additional Course XXXX …..(2-4 hr)

____**Total Hours (minimum of 12 are required)**

General Education Requirement

Writing and Communication

English 1110.xx 3 hr

Second Writing Course 3 hr

Social Science

Only one course per Social Science group may count.

3 hr

3 hr

Literature

3 hr

Visual and Performing Arts

3 hr

Historical Study

3 hr

Second Historical Study or Cultures and Ideas

3 hr

Social Diversity in the United States

Some courses may overlap with another GE category, See course list.

0 / 3 hr

Ethics

Some courses may overlap with another GE category, See course list.

0 / 3 hr

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Pre-approved substitutions

A. Credit (including EM) for a foreign language sequence through 1103, or credit for a foreign language course with a prerequisite of 1103, can be substituted for one Gen Ed course requirement as a Cultures & Ideas.
B. Completion of a foreign language minor can be substituted for two Gen Ed courses: one course as a Social Science, (Individuals & Groups or Organizations & Polities subgroups only) and one course as either a Literature or a Cultures & Ideas.

Parameters: Students must choose either Substitution A OR Substitution B. Both substitutions cannot be applied simultaneously.

University Capstone (Cross-Disciplinary Seminar)

Pre-approved substitutions

Completion of a Social Science 3597 or 4597 can be substituted for a Social Science general education course in any group. Completion of an Arts & Humanities 3597 or 4597 can be substituted for a Visual/Performing Arts general education course.

See the list of approved general education courses for additional details: www.advising.engineering.osu.edu.

Proposed Curriculum – Option 3

Yellow – Unit Ops – first course (2 credit hours) is split into two courses (1 credit hour each); no change in total
Green – reduction from 4 to 3 credit hours
Gray – combined Transport sequence (2 courses that are 4 credit hours each) that will be split into three courses that are each 3 credit hours
Red – Thermodynamics courses (currently 1 course that is 4 credit hours) that will be split into two courses that are each 3 credit hours
Cyan – courses that will be eliminated
Magenta – course that will have CBE 5779 added as a potential course to satisfy requirement
Dark Green - Two additional courses will be added, including computational methods for chemical engineers and seminar

Suggested Curriculum

This should be used as a **guide** only. Semester offerings are subject to change.

Year	Autumn	Spring
1	___ CHEM 1210 *(Gen Chem I)* 5 hr ___ MATH 114X *(Pre-Calculus)* ** 5 hr ___ ENGR 1181.xx *(Fundamentals of ENGR I)* 2 hr ___ ENGR 1100.15 *(Engineering Survey)* 1 hr ___ GE *(Launch Seminar)* 1 hr 14	___ CHEM 1220 *(Gen Chem II)* 5 hr ___ MATH 114X *(Pre-Calculus)* ** 5 hr ___ ENGR 1182.xx *(Fundamentals of ENGR II)* 2 hr ___ Engr 1221 2 hr **14**
2	___ CHEM 2510 *(Organic Chemistry I)* 4 hr ___ MATH 1151 *(Calculus I)* 5 hr ___ GE *(Writing & Information Literacy)* 3 hr ___ GE *(Historical & Cultural Studies)* 3 hr 15	___ CHEM 2520 *(Organic Chemistry II) OR Mol Gen 3300 OR Biochem 4511* 4 hr ___ GE *(Literary, Visual, & Performing Arts)* 3 hr ___ MATH 1172 *(Engineering Math A)* 5 hr ___ CBE 2200 *(Process Fundamentals)* 3 hr 15
3	___ PHYSICS 1250 *(Mechanics, Thermal, Waves)* 5 hr ___ MATH 2173 *(Mathematical Topics for Engineers)* 3 hr ___ CBE 3508 *(Thermodynamics 1)* 3 hr ___ CBE 2523 *(Separations)* 3 hr ___ CBE 2100 *(Chemical Engineering Seminar)* 1 hr 15	___ CBE 3509 *(Thermodynamics 2)* 3 hr ___ CBE 2420 *(Transport Phenomena 1)* 3 hr ___ CBE 5779 *(Design and Analysis of Experiments)* 3 hr ___ CBE 2345 *(Computational Methods for ChE)* 3 hr 12
4	___ Chem 4300 *(Physical Chemistry)* 3 hr ___ CHEM 2540 *(Organic Chemistry Lab I)* 2 hr ___ GE *(Social & Behavioral Sciences)* 3 hr ___ CBE 3730 *(Unit Operations Lab I)* 1 hr ___ CBE 3421 *(Transport Phenomena 2)* 3 hr 12	___ CBE 3610 *(Kinetics and Reactor Design)* 3 hr ___ CBE 3422 *(Transport Phenomena 3)* 3 hr ___ CBE 3731 *(Unit Operations Lab II)* 1 hr ___ GE *(Race, Ethnic, & Gender Diversity)* 3 hr ___ GE *(Citizenship for a Diverse & Just World)* 4 hr 14
5	___ CBE 3732*(Unit Operations Lab III)* 2 hr ___ CBE 4760 *(Process Design, Econ, & Strategy)* 3 hr ___ CBE 4755 *(Process Safety)* 2 hr ___ CBE 4624 *(Process Control)* 3 hr ___ Technical Elective 3 hr 13	___ CBE 4764 *(Senior Design)* 3 hr ___ Technical Elective 3 hr ___ Technical Elective 3 hr ___ GE *(Student Choice)* 4 hr 13

Total Hours to complete the degree program = 127

Program Options

Students wishing to complete the biomolecular focus will substitute Biochemistry 4511 in place of Chemistry 2520.

Acceptance Criteria

Acceptance into this program is based on the eligibility point hour ratio (EPHR) of Math 1151, 1172; Engineering 1181.xx, 1182.xx; and Chemistry 1210, 1220. A 3.2 EPHR guarantees admission during the academic year but admission is more competitive in autumn semester. Applications are accepted during autumn and spring term.

Technical and Other Electives

Students have the option to complete a biomolecular, environmental, or polymer focus for their technical elective plan. Each focus will require the completion of two approved courses in CBE plus one additional course in CBE or in another department. All students will also be required to complete one math or statistics technical elective.

____CBE XXXX…….....(3 hr)

____CBE XXXX…….....(3 hr)

____Math/Stat XXXX/CBE 5779…….(2-4 hr)

____Additional Course XXXX …..(2-4 hr)

____**Total Hours (minimum of 12 are required)**

General Education Requirement

Writing and Communication

English 1110.xx 3 hr

Second Writing Course 3 hr

Social Science

Only one course per Social Science group may count.

3 hr

3 hr

Literature

3 hr

Visual and Performing Arts

3 hr

Historical Study

3 hr

Second Historical Study or Cultures and Ideas

3 hr

Social Diversity in the United States

Some courses may overlap with another GE category, See course list.

0 / 3 hr

Ethics

Some courses may overlap with another GE category, See course list.

0 / 3 hr

Foreign Language

Pre-approved substitutions

A. Credit (including EM) for a foreign language sequence through 1103, or credit for a foreign language course with a prerequisite of 1103, can be substituted for one Gen Ed course requirement as a Cultures & Ideas.
B. Completion of a foreign language minor can be substituted for two Gen Ed courses: one course as a Social Science, (Individuals & Groups or Organizations & Polities subgroups only) and one course as either a Literature or a Cultures & Ideas.

Parameters: Students must choose either Substitution A OR Substitution B. Both substitutions cannot be applied simultaneously.

University Capstone (Cross-Disciplinary Seminar)

Pre-approved substitutions

Completion of a Social Science 3597 or 4597 can be substituted for a Social Science general education course in any group. Completion of an Arts & Humanities 3597 or 4597 can be substituted for a Visual/Performing Arts general education course.

See the list of approved general education courses for additional details: www.advising.engineering.osu.edu.

THE OHIO STATE UNIVERSITY

Effective Term: Autumn 2022

Bachelor of Science
Chemical Engineering

Students in this major will complete a minimum of 127 hours outlined as follows.

General Education Requirements		
Requirement	**Course Options**	**Hours**
GE Launch Seminar	AcadAff 1201	1
Foundations: Writing and Information Literacy [a]	***Student Choice***	3
Foundations: Mathematical & Quantitative Reasoning/Data Analysis [a]	***Math 1151****	Overlap w/ College requirement
Foundations: Literary, Visual and Performing Arts [a]	***Student Choice***	3
Foundations: Historical & Cultural Studies [a]	***Student Choice***	3
Foundations: Natural Science [a]	***Physics 1250****	Overlap w/ College requirement
Foundations: Social & Behavioral Sciences [a]	***Student Choice***	3
Foundations: Race, Ethnic and Gender Diversity [a]	***Student Choice***	3
Theme**: Citizenship for a Diverse & Just World** [b]	***Student Choice***	4
Theme: **Student Choice** [b]	***Student Choice***	4
GE Reflection	AcadAff 4001 or program required capstone	Embedded into Major Core Capstone
	General Education Credit Hours:	**24**

College/Degree Requirements [a, b]		
Requirement	**Course Options**	**Hours**
Math 1151*, 1172*, (Math & Quantitative Reasoning / Data Analysis)		10
Physics 1250* (Nat Sci)		5
ENGR 1181.0x, 1182.0x		4
ENGR 1100.01		1
	Credit Hours:	**20**

[a] Some coursework required by the major or college may satisfy GE requirements. Please add an asterisk to "student choice" for any GE category where that category can be satisfied by a required course. Please indicate in parentheses following the course listing within College/Degree requirements or Major Coursework what GE category the course satisfies (e.g., "Biology 1113 (Nat Sci)" in the Major Core for programs that require this as a prerequisite to major coursework). There is no limit to the number of courses that may overlap between the GE Foundations and the rest of the academic program

[b] Students complete either a 4-credit course or two 3-credit courses in each of two General Education Theme areas: Citizenship for a Diverse & Just World (required), and the student's choice of available GE Themes. If major-required courses are approved as a GE Theme course, one course in each GE Theme area may double count in the GE and major hours. Theme courses are identified with a ❖ symbol.

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***** These courses are can also fulfill certain GE Requirements above (may be degree requirements, pre- or co-requisites, or major courses).

Major Coursework [a, b]		
Course	**Title**	**Hours**
Major Core		
CBE 2100	Chemical Engineering Seminar	1
CBE 2200	Process Fundamentals	3
CBE 2345	Computational Methods for ChemEs	3
CBE 2523	Separations	3
CBE 3508	Thermodynamics 1	3
CBE 3509	Thermodynamics 2	3
CBE 2420	Transport Phenomena 1	3
CBE 3421	Transport Phenomena 2	3
CBE 3422	Transport Phenomena 3	3
CBE 3610	Kinetics and Reactor Design	3
CBE 3730	Unit Operations 1	1
CBE 3731	Unit Operations 2	1
CBE 3732	Unit Operations 3	2
CBE 4760	Process Design, Econ, Strategy	3
CBE 4764	Senior Design	3
CBE 4755	Process Safety	2
CBE 4624	Process Control	3
Required Non-Major Courses		
Chem 1210	General Chemistry 1	5
Chem 1220	General Chemistry 2	5
Chem 2510	Organic Chemistry 1	4
Chem 2520	Organic Chemistry 2	4
Chem 2540	Organic Chemistry Lab 1	2
Chem 4300	Physical Chemistry	3
Math 2173	Mathematical Topics for Engieers	3
ENGR 1221	Intro to Computer Programming	2
Required Technical / Directed / Targeted Electives; Career Courses		
Required Elective	Math OR Stats OR CBE 5779	3
Technical Electives	CBE OR Other courses	9
	Credit Hours:	

General Education	**24**
Required Non-Major	**28**
College/Degree Requirements	**20**
Major	**43**
Technical, Directed, Targeted Electives; Career Courses	**12**
Minimum Total Credit Hours	**127**

Degree requirements and course offerings are subject to change. Last updated on:

Policies and General Requirements for Degree

- A minimum of 121 total credit hours. Remedial coursework (English 1109; EDUTL 1001, 1002, 1003, 1004, 1005, 1006, 1007, 1010; Mathematics 1040, 1050, 1073, 1074, 1075) do not count toward the 121-hour minimum requirement for the BS degree.
- If a major-required course or major elective is a GE Theme course, two 3-4 cr courses (no more than one per theme area) is permitted to double count in the GE and major hours. GE Theme courses are indicated with a ❖ symbol. There is no limit on overlap between the GE Foundations courses and other coursework.
- Students are encouraged to participate in education abroad opportunities. Consult with your advisor for how education abroad credit applies to your degree.
- Courses required in the major (including major-supporting courses and major electives) may **not** be taken pass/non-pass.
- Coursework taken as open electives may include a maximum of 4 credit hours of physical activity courses (all 1139-1197 courses), and a maximum of 4 credit hours of campus music organizations.
- A maximum of six hours of individual studies courses (x193) can be applied toward graduation; some majors may have a lower maximum.
- **An application for degree must be submitted online at**
- **REMAINING POLICIES/REQUIREMENTS SHOULD BE LISTED HERE**

Policies and General Requirements for Minors/Minor Equivalent

- The minor/minor equivalent must contain a minimum of 12 credit hours distinct from the major and/or additional minors (i.e., if a minor requires more than 12 credit hours, a student is permitted to overlap those hours beyond 12 with the major or with another minor).
- A 2.00 cumulative point-hour ratio is required in the minor/minor equivalent with a minimum C- grade for any course to be listed in the minor or minor equivalent (includes transfer credit).
- For programs requiring a minor: minors should be declared by the time students complete 60 hours.
- A student is permitted to count up to 6 credit-hours of transfer and/or EM credit in the minor or minor equivalent.
- Coursework graded Pass/Non-Pass cannot count in the minor. No more than 3 credit-hours of course work graded S/U may count toward the minor. Maximum of 3 credit-hours of xx93 are allowed to count in the minor.

CBE 2100
Chemical Engineering Seminar

Course Information

Course title	Chemical Engineering Seminar
Course number	CBE 2100
Location	To be determined
Meeting time	To be determined
Prerequisite(s)	CBE 2200 or concurrent with CBE 2200

Instructor Information

Dr. Umit S. Ozkan
E-mail: ozkan.1@osu.edu, Office: 358 CBEC, Phone: 292-6623
https://cbe.osu.edu/people/ozkan.1

Teaching Assistant

To be determined

Course Information and Objectives

CBE 2100 is a one-credit hour course for students who have taken or are currently taking CBE 2200. The objective is to provide a general introduction to the chemical engineering curriculum, academic pathways, educational resources, career options, engineering ethics, and leadership skills. There will be guest lecturers from different industries and different professions.

Homework

There will be four homework assignments given.
Reading assignments will also be given from time to time.

Grading

Attendance	20%
Assignments	80%

Mode of delivery

The course will be delivered in person.

Attendance

Attendance will be taken at each class.

Communication

An efficient way to correspond with me, the T.A., or another student is by e-mail. **Please check your e-mail regularly.** We will also use CANVAS for communications, announcements, and discussions. Check the announcements often. If you have questions that might be of interest to others in the class, post them on CANVAS Discussion Board. **Not reading e-mail or discussion board is not an acceptable excuse for not receiving class information.**

Academic Misconduct
Academic integrity is absolutely essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. The Ohio State University presumes that all students have read and understand the University's Code of Student Conduct and that all students will complete all academic and scholarly assignments with fairness and honesty. Ignorance of this code is never considered an excuse for academic misconduct. A faculty member who believes that a student has committed academic misconduct is obligated by University Rules to report the student to the Committee on Academic Misconduct (COAM). Any students observing misconduct should report such to the course instructor. If COAM finds that the student has violated the code, then sanctions in the most serious cases could include a failing grade and suspension or dismissal from the University. The Code of Student Conduct defines Academic Misconduct to include: violation of course rules; providing or receiving information during exams; submitting plagiarized work; and falsification, fabrication, or dishonesty in reporting research results. If you have access to homework solutions prepared by students who took this course in previous years, my suggestion is to throw them away - if you rely on these to prepare your own solution that is plagiarism. For additional information, see the Code of Student Conduct

http://studentaffairs.osu.edu/csc/

and the Committee on Academic Misconduct Webpage

http://oaa.osu.edu/coamresources.html

Statement on Diversity, Equity and Inclusion
Diversity, equity and inclusion should be the guiding principles in everything we do as the members of the OSU family. I consider the classrooms and laboratories to be places where everyone, regardless of their age, background, belief, ethnicity, gender, gender identity, gender expression, national origin, race, religious affiliation, sexual orientation, ability – and all other visible and nonvisible differences, will feel valued, respected, and included. All members of this class are expected to contribute to this open, welcoming, and inclusive environment.

Statement on Title IX
All students and employees at Ohio State have the right to work and learn in an environment free from harassment and discrimination based on sex or gender, and the university can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.
If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin and disability. For more information on OIE, visit equity.osu.edu or email equity@osu.edu.

Disability Services
Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the Instructor as soon as possible of their needs.

The Office of Disability Services is located in 150 Pomerene hall, 1760 Neil Avenue, telephone: 292-3307. See their website for detailed information:

https://slds.osu.edu

Mental Health Services

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24-hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273--TALK or at suicidepreventionlifeline.org

CBE Chemical Engineering Seminar Tentative Schedule

Tentative Schedule: Updates will be posted on Carmen

Week	Date	Topics
1	8/20 (T)	• Introduction to Chemical Engineering Curriculum and Academic Paths
2	8/27	• Introduction to Educational Resources, including UG Research, Co-Op and Internships
3	9/3	• Student and Faculty Panel: How to be successful in CBE Curriculum
4	9/10	• Ethics and Professional Judgement: Societal Impact of Engineering
5	9/17	• Ethics and Professional Judgement: Social Justice
6	9/24	• Ethics and Professional Judgement: Environmental impact of engineering
7	10/01	• Teamwork: Diversity and Inclusion
8	10/08	• Teamwork: Working in a team – conflict resolution
	10/10	Fall Break
9	10/15	• Teamwork: Planning and conducting effective meetings
10	10/22	• Career Pathways: Bio/Pharma
11	10/29	• Career Pathways: Energy
12	11/05	• Career Pathways: Food/Fine Chemicals
	11/11	Veteran's Day
13	11/12	• Career Pathways: Product Development
14	11/19	• Career Pathways: Graduate Degrees
15	11/26	• Preparing your resume
15	11/28	Thanksgiving
16	12/3	• Interviewing

CBE 2200 Chemical and Biomolecular Engineering Process Calcs

A.
Class Hours: M T W Th 10:20-11:15
Location: This course will be taught solely online. Office hours with Dr. Winter and the TAs will be offered online. Course zoom links can be found in Carmen in the Zoom tab on the left near the bottom of the page.
Textbook: *Elementary Principles of Chemical Processes*, 4th Ed., Felder, Rousseau, and Bullard.

- Note: The third edition has substantial changes and is not recommended. WileyPlus is optional. It will not be used in class, but provides many examples for practice.

Course Materials
Course materials include PowerPoint lecture slides, handwritten notes, lecture recordings, worksheets with solutions, links to relevant videos, homework assignments, and exams. These materials will be available on Carmen for download at the times specified below. If additional accommodations are needed to access these materials, please inform the instructor as soon as possible. Digital solutions for exams and quizzes will not be provided, but answers can be obtained in TA or instructor office hours.

Professor: Dr. Jessica Winter
(614) 247-7668
Zoom links to be provided
winter.63@osu.edu

Office Hours
M 11:30-12:30
W 9:00-10:00
**and by appointment.*

Teaching Assistants

Connor Weyrick
weyrick.5@osu.edu

Rajdeep Mamtani
mamtani.5@osu.edu

Joe Flory
flory.77@osu.edu

TA and Instructor Office Hours Matrix

M	T	W	Th	F
11:30-12:30 Dr. Winter Zoom	11:30-1:00 Conner	9:00-10:00 Dr. Winter Zoom		
	2:00-3:30 Conner	12:30-2:00 Rajdeep	12:30-2:00 Rajdeep	
2:00-4:00 Joe		3:00-4:00 Joe		

Office hour zoom links are provided in Carmen through the zoom tab on the left.

Dr. Winter will also offer selected office hours (~ 1 mo) throughout the course with a focus on professional development. During these office hours, we will not discuss assignments, but will focus on building skills, such as resume preparation, how to apply for summer research internships, etc.

B.

Course Description

Application of physicochemical principles to problems of the chemical industry; stoichiometry and material balance. This is the first major course in chemical and biomolecular engineering. Its purpose is to introduce you to the types of processes that chemical engineers encounter and to acquaint you with the methods for evaluating, analyzing, and troubleshooting those processes. Engineering is a problem-solving profession and in this course we will draw upon your knowledge of chemistry, math, and physics as well as your computer skills to develop problem-solving skills to be used throughout the curriculum.

Prerequisites:

Prereq: Chem 1220, and Engr 1182. Prereq or concur: Math 2177, and CPHR 2.0 or above, and permission of department.

Master Objectives

This course forms the foundation for all subsequent courses in the curriculum. By the end of the quarter you should be able to:

- Master fundamentals of dimensions and unit conversions in engineering calculations
- Become familiar with chemical processes, process variables, unit operations
- Master the preparation of simple process flow sheets and performing degree of freedom analysis
- Master fundamentals of stoichiometry and material balances for reacting and non-reacting systems, including the importance of:
- recycle to minimize environmental impact and improve the economics of chemical processes

- Become familiar with phase behavior of pure components and mixtures, with emphasis on vapor/liquid equilibrium and its application to separation processes
- Be exposed to thermodynamics of non-ideal gases, with emphasis on the use of equations of state to describe volumetric behavior of non-ideal gases
- Be exposed to process data representation and analysis, including basic linear regression, and become familiar with MATLAB and Microsoft Excel as computational tools for solving material balance problems
- Demonstrate ability to work effectively in assigned teams for homework problems
- Be familiar with various forms of energy including shaft and flow work, heat, kinetic and potential energy, internal energy and enthalpy
- Master methods of obtaining thermodynamic data from tables, psychrometric charts, enthalpy-concentration diagrams.
- Be familiar with simple equations of state and how they are used to describe volumetric properties of pure and mixed materials.
- Master application of the general energy balance equation to solve a variety of problems of moderate complexity, including the simultaneous application of material and energy balances and systems involving phase changes and chemical reactions.

ABET related student learning outcomes	Course contribution		
	Some	Substantial	Significant
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics			X
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	X		
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		X	
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		X	
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	X		
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	X		

C.

The schedule may change so please check frequently.

#	Day	Lecture Date	Topic	Pages / Assignments	Example Problems
			Week 1		
1	W	25-Aug	Course introduction Syllabus What is a chemical engineer?	Ch 1. p. 3-6	9.69
2	F	27-Aug	Units	Ch 2.0-2.5a p. 7-15	2.2-1, 2.3-1, 2.4-1
			Week 2		
3	M	30-Aug	Estimation Dimensionality Statistics	Ch 2.5b-2.6 p. 15-22	2.5-1, 2.5-2, 2.6-1, 2.6-2
4	W	1-Sep	Data fitting: Interpolation, Non-linear Curve Fitting, Logarithmic Data	Ch 2.7 p. 22-30	2.7-1, 2.7-2, 2.7-3
5	F	3-Sep	The method of least squares Chapter Summary Mass Volume Flow	**Quiz #1** Ch 2.8 p. 30-31 Appendix A.1 p. 607-610 Ch 3.0-3.2, p. 42-47 Table B.1	 A.1-1 3.1-1, 3.1-2
			Week 3		
	M	**6-Sep**	**Labor Day**		
6	W	8-Sep	Mass and Mole Conversions Chemical Composition	Ch 3.3 p. 47-54	3.3-1, 3.3-2, 3.3-3, 3.3-4, 3.3-5
7	F	10-Sep	Pressure Temperature Chapter Summary	**HW #1 Due** Ch 3.4-3.6 p. 54-65	3.4-1, 3.4-2, 3.4-3, 3.5-1, 3.5-2, 3.5-3
			Week 4		
8	M	13-Sep	Chemical Processes Process Flowcharts	**Quiz #2** Ch 4.0-4.1 p. 83-84 Ch 4.3a 89-93	4.3-1
9	W	15-Sep	Basis of Calculation The General Balance Equation	Ch 4.3b p. 93-96 Ch 4.2a-b p. 85-87	4.3-2 4.2-1, 4.2-2

			Continuous, Steady-State Balance Equation		
10	F	17-Sep	Batch Balance Equation	**HW #2 Due** Ch. 4.2b-c p. 86-88	4.2-3
			Week 5		
11	M	20-Sep	Semi-batch Balance Equation Solving Mass Balances	Ch 4.2d p. 88-89 Ch. 4.3c-d p. 96-101	4.2-4 4.3-3
12	W	22-Sep	Solving Mass Balances (cont). Intro to Excel/Matlab for Simultaneous Equations Multiple Unit Balances	**Quiz #3** Ch 4.3e-Ch 4.4 p. 101-107	4.3-4, 4.3-5 4.4-1
13	F	24-Sep	Multiple Unit Balances Introducing Recycle and Bypass	Ch 4.4-4.5 p. 107-112	4.4-2 4.5-1
			Week 6		
14	M	27-Sep	Recycle and Bypass	**HW #3 Due** Ch 4.5 p. 112-116	4.5-2
15	W	29-Sep	Stoichiometry	Ch 4.6a-b p. 116-121	4.6-1, 4.6-2, 4.6-3
16	F	1-Oct	Multiple Reaction Stoichiometry Mass Balance with Reaction	**Quiz #4** Ch 4.6c-4.7e p. 121-135	4.7-1
			Week 7		
17	M	4-Oct	Mass Balance with Reaction (cont)	Ch 4.7f-g p. 135-142	4.7-2, 4.7-3
18	W	6-Oct	Combustion Chapter Summary	**HW #4 Due** Ch 4.8-4.10 p. 142-155	4.8-1, 4.8-2, 4.8-3, 4.8-4, 4.9-1
M	F	8-Oct	**MIDTERM #1 (Chapters 1-4.5)**		
			Week 8		
19	M	11-Oct	Densities of Solids Liquids and Mixtures Intro to Ideal Gas Equation	**No quiz** (midterm) Ch 5.0-5.2a p. 187-194	5.1-1, 5.2-1, 5.2-2

20	W	13-Oct	Ideal Gas Equation- Standard T and P		5.2-3, 5.2-4
	F	15 Oct	Fall Break		
			Week 9		
21	M	18-Oct	Ideal Gas Mixtures	**No HW** (midterm) Ch. 5.2c p. 196-199	5.2-5
22	W	20-Oct	Factors of Non-Ideality Non-ideal Gases	Ch. 5.3 p. 200-206	5.3-1, 5.3-2, 5.3-3
23	F	22-Oct	Solving EOS in Matlab and Excel Compressibility	**Quiz #5** Ch 5.4a-b p. 206-210	5.4-1, 5.4-2
			Week 10		
24	M	25-Oct	Nonideal gas mixtures Single Phase Equilibria	Ch 5.4c-5.5 p. 210-214 Ch 6.0-6.1a p. 237-243	5.4-3
25	W	27-Oct	Gibbs Rule Single Component Gas-Liquid Systems	Ch 6.2-6.3 p. 247-255	6.2-1, 6.3-1, 6.3-2, 6.3-3
26	F	29-Oct	Multi component Gas-Liquid Systems Raoult's Law, Henry's Law	**Quiz #6** Ch 6.4 p. 255-259	6.4-1, 6.4-2
			Week 11		
27	M	1-Nov	Txy and Pxy Diagrams Solids in Liquids	Ch 6.4c-6.5b 259-268	6.4-3, 6.4-4, 6.4-5 6.5-1, 6.5-2, 6.5-3
28	W	3-Nov	Solids in Liquids (cont.) Liquid-Liquid Equilibria	**HW #6 Due** Ch 6.5c-6.6a p. 268-273	6.5-4, 6.6-1
29	F	5-Nov	Adsorption on Surfaces Chapter Summary Types of Energy	Ch 6.6b-7.1 273-316	6.6-2, 6.7-1
			Week 12		
30	M	8-Nov	First law of thermodynamics Energy Balances on Closed Systems	**Quiz #7** Ch 7.2-7.4a 316-321	7.2-1, 7.2-2, 7.3-1
31	W	10-Nov	Energy Balances on Open Systems Enthalpy Tables of Thermodynamic Data	Ch 7.4b-7.5 p. 321-329 Tables B.5-B.7	7.4-1, 7.4-2, 7.5-1, 7.5-2, 7.5-3
32	F	12-Nov	Energy Balance Procedures	**HW #7 Due** Ch 7.6 p. 329-332	7.6-1, 7.6-2

			Week 13		
33	M	15-Nov	Simultaneous Mass and Energy Balance Mechanical Energy Balance Chapter Summary	Ch 7.6-7.7 p. 332-334	7.6-3
34	W	17-Nov	Mechanical Energy Balance (cont) Chapter Summary Process Paths Type 1 Path: ΔP @ Const T	**Quiz #8** Ch 7.7 p. 334-340 Ch 8.0-8.1b p. 357-360 Ch 8.2 p. 365-366	7.7-1, 7.7-2, 7.7-3
35	F	19-Nov	Type 2 path: ΔT @ Const P	Ch 8.3a-8.3c p. 366-373 Tables B.2, B.8, B.9, B.10	8.3-1, 8.3-2, 8.3-3, 8.3-4
			Week 14		
36	M	22-Nov	Type 2 path: ΔT @ Const P (cont) Type 3 Path: Δ Phase @ Const T,P	**HW #8 Due** Ch 8.3d-8.4b p. 373-382 Table B.1	8.3-5, 8.3-6, 8.4-1, 8.4-2, 8.4-3
	W	24-Nov	No Class		
	F	26-Nov	No Class		
			Week 15		
M	M	29-Nov	**MIDTERM #2 (Chapters 4.6-7)**		
37	W	1-Dec	Type 3 Path: Δ Phase @ Const T,P (cont.) Process paths	**No quiz (midterm)** Ch 8.4b-c p. 379-384 Ch 8.1b-c p. 360-365	8.4-4 8.1-1
38	F	3-Dec	Type 4 Path: ΔMix @ Const T, P	Ch 8.5a-b p. 395-398 Table B.11	8.5-1
			Week 16		
39	M	6-Dec	Enthalpy Concentration Charts	**Quiz #9** Ch. 8.5c p. 399-403 Fig 8.5-1	8.5-2, 8.5-3
40	W	8-Dec	Multiphase Enthalpy Concentration Charts Chapter Summary	**HW #9 Due** Ch 8.5d-8.6 p. 403-409 Fig. 8.5-2	8.5-4, 8.5-5 9.1-1, 9.1-2

			Type 5 Path: Reaction @ Const T, P Heat of Reaction	Ch 9.0-9.1 p. 440-445	
F	**W**	**9-Dec**	**FINAL EXAM (10:00-11:45 AM)**	-	

D.
Final grades will be determined by the components listed in the table below.

Component	**% Total**
Participation	5
Homework (12)	20
Quizzes (12)	25
Midterms (2)	25
Final (1)	25
Total	100

Exams will not be curved, but final grades may be adjusted at the end of the quarter. You will be graded on your performance relative to the rest of the class, but your grade will not be curved down.

Participation
Your participation grade will be based on two components: course attendance and evaluation by your homework group members. You will be evaluated by your fellow group members at the end of the term. An average participation grade is an 80%, i.e., a 4 out of 5. Very few students will receive 5%.

Homework
Homework will be assigned each week and will cover topics discussed previously in class. Homework will be assigned from the book, include problems developed by peers, and consist of some hands-on experiments.

- There will be 12 homework assignments.
- Each homework assignment will consist of some group and some individual problems. Groups will be assigned after the first class.
- HW will be posted on Thursdays via Carmen.
- HW will be due the following Thursday by the end of class, 11:15 AM.
- Assignments must be turned in during class, or in extreme circumstances, may be scanned and emailed to me.
- Some portions of HW may also be turned in via Carmen dropbox. These assignments must be uploaded by Thursday 11:15 AM or they will be considered late.
- HW will be returned by the following Thursday.
- No homework scores will be dropped, but one homework score can be replaced by an extra credit assignment (see below).
- For late HW policy, please see policies (next section of syllabus).

Quizzes
Quizzes will cover general concepts that have been learned in homework or presented in class. Previous quizzes have consisted of two conceptual questions and one numerical question. An example quiz is posted on Carmen.

- There will be 12 quizzes.
- Quizzes will be given on Tuesdays during the last 20-30 minutes of class.
- No quizzes will be dropped, but one quiz score can be replaced by an extra credit assignment, please see policies (next section of syllabus).
- Quizzes will be returned by the following Tuesday.

Midterms and Final
The midterms and final will each be worth 25% of your grade. The midterms will cover Chapters 1-4 and Chapters 4-7. The final will be comprehensive, with special emphasis on Chapters 7-10.

E.
Attendance
You are expected to attend all class sessions. If you need to miss class because of some other activity, you should send me an email before class to let me know you will be absent. If you have to miss for some unexpected reason (e.g., car trouble, illness) then you should send me a short explanation either by email or phone as soon as possible afterwards. If your absence results in a missed quiz or late homework, prompt notification makes it possible for alternative arrangements to be made. If notification is received the day following class or later, it will be very difficult to make arrangements for quiz make-ups or handing in homework. It is not fair to students who were in class as scheduled, especially when you may receive extra homework time or feedback on quiz material in the intervening time.

Reading Assignments
It's also very important that you read the assigned sections from the textbook before coming to class. You've paid big $$ for this book - read it! The purpose of our class sessions are not to simply review material described in the textbook; in fact, I will assume you've read the assigned material and understood most of it. Be sure to come to class prepared to ask questions that arise when reading the book. We will review difficult concepts in class, but will spend much of our time solving problems and getting hands-on practice developing our problem solving skills. If you haven't read the book before coming to class, you won't be ready to participate in these activities.

Homework
Homework will be assigned Thursday (via Carmen) and due the following Thursday. Unless instructed otherwise, completed assignments must be submitted to the instructor by end of class: 11:15 AM Thursday. Your graded assignment will be returned within 1 week.

Late homework must still be completed and submitted by the end of term, but there's a 50% penalty for being late. Failure to submit homework will result in a score of 0 for that assignment and an incomplete in the class.

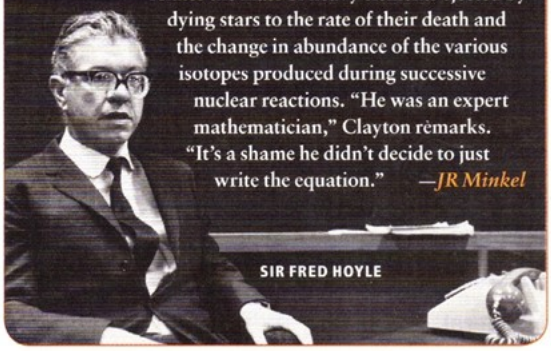
Not Showing His Work

The failure to include a key equation may have kept Sir Fred Hoyle from getting the recognition he deserved for a paper on the formation of elements in stars. Hoyle, who died in 2001 at the age of 86, was something of a tragic scientific figure. He never accepted the big bang theory, preferring instead the idea of a steady-state cosmos; later, he embraced the view that life on Earth originated in outer space. These attitudes probably cost him a Nobel Prize [see the profile of Hoyle, "The Return of the Maverick"; SciAm, March 1995].

But before his scientific infamy, Hoyle made what should have been a lasting contribution with a 1954 *Astrophysical Journal* paper laying out a process by which stars heavier than 10 suns would burn the hydrogen and helium at their cores into heavier elements through a progressively hotter series of nuclear fusion reactions. When such a star finally exploded in a supernova, it would scatter these elements into space, where they would seed still-forming star systems. Prior to Hoyle's work, many experts believed that the elements must have been born during the big bang.

Instead of citing the study, researchers discussing the formation of elements, or nucleosynthesis, typically reference a 1957 paper, co-authored by Hoyle, which focused on other facets of the problem, says Donald Clayton of Clemson University, who was a colleague of Hoyle's. Clayton found that of 30 major nucleosynthesis papers published between 1960 and 1973, 18 cited the 1957 work and only one gave the nod to Hoyle's 1954 paper.

Writing in the December 21, 2007, issue of *Science*, Clayton attributes the misplaced citation to the lack of a relatively straightforward equation that was implicit in the 1954 study. "Hoyle's equation," as Clayton calls it, relates the mass of heavy elements ejected by dying stars to the rate of their death and the change in abundance of the various isotopes produced during successive nuclear reactions. "He was an expert mathematician," Clayton remarks. "It's a shame he didn't decide to just write the equation." —*JR Minkel*



SIR FRED HOYLE

In industry, virtually all work is conducted in groups. Therefore, each homework assignment will contain both group and individual problems.

Group Homework

Homework groups consisting of 3-5 students will be assigned by the instructor. Homework assignments submitted as a team must consist of a single solution. For each assignment, your team will select one member to act as "scribe", the person who writes up the solution for that particular assignment. Each student is expected to serve as scribe for at least one assignment during the semester. My idea of teamwork is not to have each student solve a different problem and then combine or "pool" the results - this is called cheating! Having one student do the calculations on a computer and then give a copy of the results to other students is also cheating. The primary goal of your team is to make sure that each and every member of the team understands the solution to each and every problem. Your team will work together throughout the semester and at the end of the semester you will have an opportunity to rate your teammates' performance.

Individual Homework

For other homework problems, each student will be expected to submit their own solution individually. It's still OK to work together on these problems as long as you don't abuse the privilege. The proper way is for each student to first look over the problems on their own, then meet with others to identify problems that are especially difficult and discuss/debate strategies for solving them. Each student should then prepare his/her own solution for each problem.

It is never acceptable for you to copy solutions from classmates or from solution sets from previous years to which you may have access. Presenting someone else's work as your own is plagiarism. I realize that attaining the proper balance between group and individual efforts can be confusing, so please don't hesitate to ask me if you have any questions about this policy. Be aware that I am obligated by University rules to initiate academic misconduct proceedings if I suspect cheating is taking place.

Format for Homework

It is expected that all assignments will be neat and easy to read. Quality of work should be such that you would submit it to your supervisor in industry. **Note that an example of homework formatting and documentation expected is provided on Carmen.**

- Assignments must be worked on engineering or plain white paper (no lines). Write only on one side of each sheet of paper and start each problem on a new page.
- At the top of the first page, write your full name, date, and your personal mailbox number. Each subsequent page must be numbered and have your name written at the top. For group work, use the name and mailbox of the scribe.
- Group assignments should include signatures of all group members on the last page. This is an affirmation of your agreement with the work turned in. You are indicating that you accept the results and that you have contributed to them.
- Each problem should include a problem statement. You do not need to copy directly from the text, just summarize the general points. When appropriate, draw and label a flowchart for the process described in the problem statement.
- Next include the information provided (knowns), equations to be used, and information to be determined (unknowns). State all assumptions you make and cite sources of data used in your calculations (e.g., Table B.1). Clearly define any algebraic variables used in your solution - be consistent with those used in the text and during lecture.
- All steps of a solution should be shown and easy to follow. Your final results must be clearly indicated (boxed or underlined) - don't make us hunt for your answers! It is easier to offer partial credit when the grader can follow your train of thought. Please provide as much information as possible to make this achievable. (See left, Not Showing his Work)
- Numerical answers must have correct units - a number without proper units is as meaningless as units without a number.

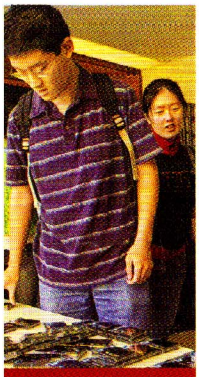
Correct use of significant figures is also important.

- When necessary, graphs should be prepared using a computer graphing program (e.g., Microsoft Excel or MATLAB). Graphing software is available to you in the ChE computer lab. Do not use engineering paper - the grid used on engineering paper is too course for preparation of accurate graphs. Graphs should include a descriptive title and each axis must be properly labeled, including units. All text should be readable, 12 pt font.

Students who chew gum before or during an exam may spit out higher scores. In an admittedly unscientific study involving nearly 600 students in a Cornell University marketing class, those who chewed gum during an exam achieved a mean score of 90 compared with the overall class mean of 78.

The students received a sample pack of Wrigley's new gum called "5" the day before their exam. During the exam, they indicated whether they had chewed any and whether they were chewing during the exam.

Ed McLaughlin, who teaches the introductory marketing class, noted that students who had chewed none of the gum received a mean score of 60. Students who chewed several pieces before the exam had a mean score of 81, and those who chewed the entire pack had a score of 86.



JASON KOSKI/CORNELL UNIVERSITY

ythons in trouble.
st for flavor.

"There was no control group; we did this just for fun. But there were over 150 people in each of the categories," McLaughlin noted.

The survey results couldn't have turned out better for the Chicago-based chewing gum maker. The company claims gum can have benefits other than as a breath freshener. Recent research, it claims, has shown that chewing gum increases blood flow to the brain by some 25%, potentially increasing concentration and test performance.

Its website cites a 2002 study, "Chewing Gum Selectively Improves Aspects of Memory in Healthy Volunteers," in the journal *Appetite* (**38,** 235), by researchers at the University of Northumbria, in the U.K.

- Your assignment must be stapled together when submitted- we are not responsible for lost pages if you do not staple your work.

In addition, after solving a problem, always take a second look at your answer and ask yourself whether or not it seems reasonable. If not, don't attempt to "fudge" your calculation, but write a brief comment indicating that you suspect your answer is incorrect. For example, if you end up with a negative absolute pressure, we will be more lenient grading your work if you tell us you know that this is an impossible result. We will not be lenient if you report the negative value with no comment, or if you simply change the negative sign to a positive and try to fool us.

Make-Up HW or Quiz Policy

One quiz **and** one composite HW score may be replaced by separate extra credit assignments. Each assignment will consist of designing and solving either a HW or quiz problem relevant to the material being replaced (e.g., HW replaces HW, Quiz replaces Quiz). The make-up will be graded based on the difficulty of the problem and correctness of the solution. Problems should resemble those assigned. If the problem requires a chart or table (i.e., Enthalpy concentration diagram, Psychrometric chart), a copy of the chart with your answer drawn on it must be provided. Please turn in make-ups as soon as possible. If your answer is incorrect or the problem is ill-conceived, you will be given the opportunity to make corrections. Assignments and corrections will be accepted up to the last day of class (12/04). No further assignments OR corrections will be accepted after this date.

Exams

All exams are open-book and open-notes. You should **not** assume this means you do not have to study as long or prepare as thoroughly as you would for a closed book test. Several past students have convincingly proven this theory to be wrong! The use of any electronic equipment other than a standard calculator is not allowed during exams. This includes laptop computers, mobile phones, tablets, pagers, etc. **Any attempt to use a wireless communications device of any kind during an exam will be treated as academic misconduct.**

Missed Exams

If you will be unable to attend a midterm or final for a valid reason, please notify the instructor *at the beginning of the semester*. Accommodation can be made if sufficient notice is given, but if notice is not provided until after the exam has been given, an oral exam conducted by the instructor will be required. Getting a good deal on your flight home is NOT a valid excuse for missing the final.

If you are unable to attend an exam as a result of an emergency (i.e., illness, death in the family, car trouble), please notify the instructor immediately. Proof of emergency will be required (i.e., Doctor's note, Parent's note or death certificate, car repair or towing receipts) before make-up exam will be administered. Exams must be made-up as soon as possible. Because final grades are due by **Dec 16th**, you *will* receive an incomplete if the final exam has not been taken by this time. In order to ensure fairness to students taking the exam at the scheduled time, make-up exams will be oral, conducted by the instructor.

NOT 2 BE MISSED

All-nighters little help for students

By Michael Virtanen
ASSOCIATED PRESS

ALBANY, N.Y. — Students who rely on all-nighters to bring up their grades might want to sleep on that strategy: A new survey says those who never study all night have slightly higher GPAs than those who do.

A survey of 120 students at St. Lawrence University, a small liberal-arts college in northern New York, found that students who have never pulled an all-nighter have average GPAs of 3.1, compared with 2.9 for those who have. The study, by assistant professor of psychology Pamela Thacher, is to be included in the January issue of *Behavioral Sleep Medicine.*

"It's not a big difference, but it's pretty striking," Thacher said. "I am primarily a sleep researcher and I know nobody thinks clearly at 4 in the morning. You think you do, but you can't."

A second study by Thacher, a clinical psychologist, had "extremely similar" results showing lower grades among the sleep skippers.

Many college students, of course, have inadequate or irregular sleep, for reasons ranging from excessive caffeine to poor time management.

Prav Chatani, a St. Lawrence sophomore who wasn't involved in either study, said the findings make sense. The neuroscience major has been pulling fewer all-nighters, but recently stayed up until "around 4 or 5 in the morning" to prepare for an organic chemistry test and a neuroscience presentation, he said.

The next day, he found himself unable to remember some of the things he had studied.

"A lot of students were under the impression all-nighters were a very useful tool for accomplishing work, that caffeine intake was very useful in meeting deadlines and stuff like that," said Chatani, who had a 3.4 GPA last semester.

Dr. Howard Weiss, a physician at St. Peter's Sleep Center in Albany, N.Y., said the study results make sense.

"Certainly that data is out there showing that short sleep duration absolutely interferes with concentration, interferes with performance on objective testing," he said.

Some night owls do get good grades, of course, which may be explained by circadian rhythms, Weiss said. Circadian rhythms can be tracked through body temperature and hormonal transmissions.

Some people have different 24-hour body clocks than others, and may do better depending on class and testing times, Weiss said.

ChloJe LaFrance, a St. Lawrence junior from Elizabethtown, N.Y., majoring in psychology and English, said she's never studied all night. "If I get less than six hours of sleep I just do not function."

BREAKING NEWS: DISPATCH.COM

Posting Grades

To ensure confidentiality, grades will not be publicly posted. Instead, grades will be posted on Carmen. You should regularly check your scores on Carmen. This will make sure we catch any mistakes early, and it will help you know how you're doing as the semester progresses. Please contact me with any questions - there should never be any mysteries or surprises when you receive your final grade at the end of the semester.

If you are unsatisfied with your performance, I strongly encourage you to seek help as soon as possible. The TAs and instructor have office hours and are available to help you.

If you "need" a certain grade for your scholarship, to stay off probation, etc. the time to come forward with that information is at the beginning of the semester when the instructor can help you to craft a specific plan to achieve that goal. The end of the term is too late.

Office Hours
I strongly encourage you to take advantage of office hours. In my experience, students who regularly come by with questions almost always improve their performance significantly. The teaching associates (TA's) and I will keep regularly scheduled office hours. We try to set times that are convenient for as many students as possible. If you are unable to attend scheduled hours, you may contact the TAs or me to make an appointment for an alternative meeting.

Additionally, I will check Carmen discussion board and my email as frequently as possible. This is a good avenue for you to ask questions especially if you are uncomfortable approaching us directly. I prefer that questions be posted on Carmen so that all students may benefit from the answer. If you are having difficulty with a particular concept, chances are other students are too. However, if you have a question that you prefer to address directly to myself or the TAs please email.

Please be aware that Professors have many different duties, including meeting with graduate students, writing grant proposals and research papers, sitting on dissertation committees, performing service for the university, and outreach to K-12 schools (not to mention families! (Left)). I will do my best to address questions as soon as possible.

Check your Email and the Carmen Discussion Board Every Day
I will expect you to check your email at least once a day. You are responsible for all information sent to you by email to your osu.edu or chbmeng.ohio-state.edu addresses. "I didn't know because I forgot to check my email" is not an acceptable excuse.

I will also assume that you regularly check the Carmen discussion board for this course. Rather than sending out mass emails, it's much more efficient to use the discussion board to post announcements or answers to common questions.

Check your mailbox before class
Graded homework assignments and quizzes will be placed in your personal mailbox.

Requests for Regrades

The instructor and TA's have been known to occasionally make mistakes when grading. If you believe a mistake was made and that you deserve more points on a homework or exam, you must write a short note of explanation and resubmit your work directly to the instructor. You must do this within one week after the assignment in question is returned. Assignments resubmitted after one week will not be considered for correction. Please be aware that assignments and exams submitted for regrade will be examined in their entirety. **Do not discuss grading issues with the TA's or expect them to change your score unless instructed to do so.**

Please read the preceding paragraph on the re-grade policy again! If you attempt to get additional credit without following the proper procedure, your appeal will be automatically denied. Case closed!

Computers and Computational Tools
You should have obtained a computer account with your enrollment in ChBE 2200. If you do not have an account, please contact Geoff Hulse or Brian Endres. Although you'll be using software installed on the PCs in the computing labs for many of your calculations, I will also expect that you have a good engineering calculator and know how to use it. Powerful calculators are available these days at a very reasonable cost. At a minimum, your calculator should have all the fundamental math functions and the following built-in applications: (1) an equation solver (often called a "root finder"); (2) basic statistical functions, including linear least squares regression; (3) numerical integration. I don't recommend buying more calculator than you need; some of the calculators these days are packed with so many features (most of which you'll never use) that it takes a considerable effort to learn how to use them to do even simple tasks.

WileyPlus
WileyPlus is an electronic supplement to the text that includes additional practice problems, etc. It is not required for the course.

F.
The Department of Chemical and Biomolecular Engineering has academic standards intended to ensure that every graduate attains the level of competency expected of a professional engineer. A detailed description of these policies can be viewed at:
http://cbe.osu.edu/undergraduate/resources/forms-and-department-information

The part of the policy that is most pertinent to you in ChBE 2200 is that students must pass 2200 with at least a C- before continuing to subsequent courses. This policy reinforces the importance of the material taught in this class because we have found that students who do not have a strong grounding in mass and energy balances often struggle or fail in higher level courses. This policy only applies to 2200; in all other ChBE courses, the minimum passing grade is D.
G. Academic integrity is absolutely essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. The Ohio State University presumes that all students have read and understand the University's Code of Student Conduct and that all students will complete all academic and scholarly

assignments with fairness and honesty. Ignorance of this code is never considered an excuse for academic misconduct. A faculty member who believes that a student has committed academic misconduct is obligated by University Rules to report the student to the Committee on Academic Misconduct (COAM). Any students observing misconduct should report such to the course instructor. If COAM finds that the student has violated the code, then sanctions in the most serious cases could include a failing grade and suspension or dismissal from the University.

The Code of Student Conduct defines Academic Misconduct to include: violation of course rules; providing or receiving information during quizzes or exams; submitting plagiarized work; and falsification, fabrication, or dishonesty in reporting research results.

If you have access to homework solutions prepared by students who took this course in previous years, my suggestion is to throw them away - if you rely on these to prepare your own solution that is plagiarism. The same obviously is true for students who somehow manage to obtain a copy of the solutions manual for a textbook.

Collaboration on homework assignments is encouraged in this class - discussing problems with classmates can be a great way to learn. However, unless instructed otherwise, each student must submit their own individual solution. If you have any questions, please contact the professor for clarification.

For additional information, see the Code of Student Conduct
http://studentaffairs.osu.edu/csc/
and the Committee on Academic Misconduct Webpage
http://oaa.osu.edu/coamresources.html

H.
Students with disabilities that have been certified by the Office for Disability Services (ODS) will be appropriately accommodated and should inform the instructor as soon as possible of their needs.

The ODS offers a wide variety of services to students with documented permanent or temporary disabilities. All types of disability are covered, including physical (mobility, dexterity, endurance, etc.), perceptual, cognitive (attention, distractibility, communication, etc), and behavioral.

If you believe that you may have a disability, please contact the Office of Disability Services as soon as possible so that accommodation may be provided. The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Ave; telephone 292-3307. See their website for detailed information:

https://slds.osu.edu/

I.

Health and safety requirements
All students, faculty and staff are required to comply with and stay up to date on all university safety and health guidance (https://safeandhealthy.osu.edu), which includes

wearing a face mask in any indoor space and maintaining a safe physical distance at all times. Non-compliance will be warned first and disciplinary actions will be taken for repeated offenses.

Counseling Services Available
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation, or concern over the health of yourself or your family members. You may struggle with imposter syndrome or feelings of not belonging. These mental health concerns or stressful events may lead to diminished academic performance or reduce your ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing.

If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting https://ccs.osu.edu/ or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614-292-5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-TALK or at http://suicidepreventionlifeline.org.

Everyone experiences mental health challenges from time to time (including me!). It is a normal part of life. **If you are not comfortable reaching out to a counselor or counseling is not available in a timely manner, please do not hesitate to reach out to me. I will help you to the best of my ability.**

J.

Diversity is a fundamental part of our profession, valued by our university, college, department, professional organizations, and industry members that hire our students. Many academic studies highlight the importance of diversity in the engineering profession. This peer-reviewed research directly supports the value of working with individuals whose viewpoints are formed by their unique perspective on the world. In this course, you will work in groups. You will do yourself and your group a disservice if you do not fully utilize the resources that each individual provides to the group. Further, I strongly encourage you to consider forming a diverse peer network outside your group to discuss and review course materials. We need all hands on deck to solve the world's challenging engineering problems!
Peer Reviewed Research Highlighting the Importance of Diversity in Engineering
https://www.nap.edu/read/10377/chapter/4
https://search.informit.com.au/documentSummary;dn=199154901624228;res=IELENG
https://doi.org/10.24908/pceea.v0i0.9486
https://www.pnas.org/content/117/17/9284
(and many more!!!)

University and College Resources:
The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.
https://www.osu.edu/initiatives/diversity.html
https://engineering.osu.edu/diversity
The AIChE states:
"We work towards a better future for all — not just through our technical expertise but through how we inspire, engage, retain and advance future talent, and how we treat each other within and beyond the profession…We believe that some groups experiencing historical and present discrimination continue to face specific challenges in entry to or participation in engineering and science professions. AIChE holds forth a vision of the profession in which discrimination and conscious or unconscious bias is unwelcome and unacceptable. Efforts to support and promote diversity must also address root causes of inequities and narrow gaps, not just their manifestations."
https://www.aiche.org/equity-diversity-inclusion/statement
Similarly, ACS recognizes the importance of diversity:
"We encourage inclusivity and oppose discrimination in scientific learning and practice based on - but not limited to - race, religion, country or ethnic origin, citizenship, language, political opinion, sex, gender identity and expression, sexual orientation, disability, age, and economic class in academic, industrial, and government workplaces. The Society believes that an enduring commitment to diversity enables excellence, innovation, and transformative action in current and future generations of chemical professionals."
https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html

Title IX
Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu
Reporting
To report an issue with Title IX or any other form of discrimination (e.g., racial, gender, sexuality, religion), please reach out to me or the department chair Umit Ozkan (ozkan.1@osu.edu). We are committed to an equitable, supportive, and nurturing educational environment.

Computational Methods for Chemical Engineering
CBE 2345, Fall 20XX

Professor: Joel Paulson, paulson.82@osu.edu, 416 CBEC

Teaching Assistants:
TBD

Class Time:
TBD

Office Hours:
Joel Paulson Location: 416 CBEC, but move to 415 CBEC if it gets crowded
Time: TBD

Website:
The Carmen/Canvas website for the class will have all homework assignments posted and the solution keys for homework and exams along with class handouts and any important announcements.

Course objectives:
Chemical engineering problems, such as those related to material balances, transport phenomena, thermodynamics, and kinetics, are often described by a complex set of mathematical equations that cannot be solved analytically. As such, the main goal of this course is to introduce students to a variety of different computational methods/algorithms to develop solutions to these types of challenging problems that commonly arise when modeling chemical and biomolecular systems. The course will also equip students with the ability to apply and implement these algorithms on a computer using a programming environment (such as Matlab or Python) as well as visualize the corresponding solutions. The example problems and case studies are specifically designed to elucidate challenges that are unique to chemical engineering problems. Thus, another goal of this course is for the covered concepts to be applicable within junior and senior level CBE courses and undergraduate research projects as well as help students read/interpret technical scientific and engineering literature.

Textbook:
A Numerical Primer for the Chemical Engineer, 2nd Edition (Zondervan, CRC Press, 2020)

Topics:
1. Course overview and Matlab tutorial
2. Solving systems of algebraic equations
3. Numerical optimization
4. Data regression and curve fitting
5. Ordinary differential equations
6. Numerical Integration
7. Differential algebraic equations
8. Partial differential equations (if time permits)

Grading:
Homework: 30%
Midterm Exams (2): 40%
Final Exam: 30%

A. **Homework assignments (30%)**
A total of 9 assignments must be uploaded ***electronically*** to the Carmen system by 11:59pm on the due date. You will have approximately 1 week to complete most assignments but may be given up to 2 weeks for some of the assignments. Homework that is turned in late will NOT be accepted (no credit). Each homework assignment constitutes 3.33% of the final grade.

Please note that discussing homework assignments with your classmates is okay. However, you must complete the assignment yourself and develop your own solutions – do not directly copy solutions as this constitutes academic misconduct (see the Academic Misconduct Statement below for further clarification).

B. **Midterm Exams (2x20% = 40%)**
There will be two midterm exams that will be held during regular class time. The midterm exams will be closed book and are designed to take approximately 1 hour 20 minutes.

C. **Final Exam (30%)**
The final exam will be hold on TBD from TBD. This is a *comprehensive* closed book exam.

Regrading policy: If you believe an exam problem was graded incorrectly, write a statement making your case and submit it to me via email (paulson.82@osu.edu). Any regrade requests must be submitted **within one week** of the date when the exam is returned to class.

Makeup policy: No makeup exams will be given. A student with a ***documented excuse for an absence*** will be given a score for the missed exam equal to the average of the remaining exams and the final. For example, if you have an excused absence for Exam 1, your Exam 1 score will equal the average for Exam 2 and the final.

Schedule: Please see the file "Tentative_schedule.pdf".

Disability Services Statement: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor as soon as possible of their needs. The Office for Disability Services is in 098 Baker Hall, 113 W. 12th Avenue; telephone 292-3307, TDD 292-0901, VRS 429-1334; http://www.ods.ohio-state.edu/

Academic Misconduct Statement: Academic integrity is absolutely essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. The Ohio State University presumes that all students have read and understand the University's Code of Student Conduct and that all students will complete all academic and scholarly assignments with fairness and honesty. Ignorance of this code is never considered an excuse for academic misconduct. A faculty member who believes a student has committed academic misconduct is obligated by University Rules to report the student to the Committee on Academic Misconduct (COAM) Any students observing misconduct should report such to the course instructor. If COAM finds that the student has violated the code, then sanctions in the most serious cases could include a failing grade and suspension or dismissal from the University.

The Code of Student Conduct defines Academic Misconduct to include: violation of course rules; providing or receiving information during exams; submitting plagiarized work; and falsification, fabrication, or dishonesty in reporting research results. If you have access to homework solutions prepared by students who took this course in previous years, my suggestion is to throw them away - if you rely on these to prepare your own solution, that is plagiarism. The same is true for students who somehow manage to obtain a copy of the solutions manual for a textbook.

Collaboration on homework assignments is encouraged in this class - discussing problems with classmates can be a great way to learn. However, unless instructed otherwise, each student must submit their own individual solution. If you have any questions, please contact the instructor for clarification.

Counseling and Consultation Services (CCS) Statement: As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life Counseling and Consultation Services (CCS) by visiting ccs.osu.edu or calling (614) 292- 5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at (614) 292-5766 and 24 hour emergency help is also available through the 24/7 National Prevention Hotline at 1-(800)-273-TALK or at suicidepreventionlifeline.org

Computational Methods for Chemical Engineering
CBE XXXX, Fall 20XX

Tentative schedule for course:
Updates will be posted on Carmen.

Class	Date	Topic	Assignments
1	TBD	Syllabus, Course Introduction, & Role of models in ChemE	
2	TBD	Matlab tutorial & errors in computer simulations	HW0 (optional)
3	TBD	Matlab tutorial, continued	
4	TBD	Linear systems and matrices	HW1 due
5	TBD	Eigenvalues, eigenvectors, spectral decomposition	
6	TBD	Linear algebraic equations (elimination methods)	HW2 due
7	TBD	Linear algebraic equations (iterative methods)	
8	TBD	Nonlinear algebraic equations (Newton’s method)	
9	TBD	Nonlinear algebraic equations (Quasi-Newton’s method)	
10	TBD	Numerical optimization (linear programming)	HW3 due

11	TBD	**Midterm Exam #1**	
12	TBD	Numerical optimization (nonlinear programming, concepts)	
13	TBD	Numerical optimization (nonlinear programming, algorithms)	
14	TBD	Random variables & probability distribution functions	HW4 due
15	TBD	Conditional random variables & Bayes' rule	
16	TBD	No class (fall break)	
17	TBD	Regression and curve fitting (least squares)	
18	TBD	Regression and curve fitting (regularization)	HW5 due
19	TBD	Regression and curve fitting (cross-validation)	
20	TBD	Ordinary differential equations (finite difference)	
21	TBD	Ordinary differential equations (Euler & Runge-Kutta methods)	HW6 due
22	TBD	Ordinary differential equations (Stability & stiffness)	
23	TBD	Numerical integration (trapezoidal and Simpson's method)	
24	TBD	**Midterm Exam #2**	
25	TBD	Numerical integration (Monte Carlo)	
26	TBD	Differential algebraic equations (introduction & applications)	HW7
27	TBD	Differential algebraic equations (index & solution methods)	
28	TBD	Boundary value problems (shooting methods)	HW8
29	TBD	Boundary value problems (finite difference & collocation)	
30	TBD	No class (Thanksgiving)	
31	TBD	TBD (introduction to PDEs, if time permits)	HW9
32	TBD	No class (reading day)	
33	TBD	**Final Exam**	

CBE 2420

Transport Phenomena I

Description

The transport of energy, mass and momentum is essential to the function of all non-living and living systems. This course will serve as an introduction to momentum transport (i.e. fluid mechanics), and will primarily focus on the basic mechanisms of momentum transport and its application to the analysis of real world flows.

Level	Credits	Weekly Class Time Distribution	Semesters Offered	Prerequisites	Cross-Listing
Undergraduate	3	Three 55-min lectures and	Fall/Spring	CBE 2200, MATH 2177	

Instructor

Professor Andre F. Palmer
E-mail: palmer.351@osu.edu
Telephone #: (614) 292-6033

Office Hours

Monday	9 – 11 am
Wednesday	9 – 11 am

CBEC 452

and by appointment

Teaching Assistants

Kristopher Richardson (e-mail: richardson.671@.osu.edu)
Chia-Wen Chang (e-mail: chang.1346@osu.edu)
Yu Zhang (e-mail: zhang.4951@osu.edu)
Rafael Deleon (e-mail: deleon.56@osu.edu)

Teaching Assistant Office Hours (sixth floor of CBEC)

Kristopher Richardson
Tuesday 11-4 pm

Chia-Wen Chang
Monday 7-9 pm
Tuesday 4:30 - 6 pm
Friday 12:30 - 2 pm

Rafael Deleon
Monday 12-2 pm
Wednesday 12-2pm and 7-8 pm

Yu Zhang
Thursday 5:30-8 pm
Friday 5:30-8 pm

Class Hours:

Monday, Tuesday, Wednesday: 8 am - 8:55 am; **Location:** Ramseyer Hall 059

Textbook

R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot *"Transport Phenomena"* Wiley & Sons (2007), Revised 2nd Ed.
.

Topics

1) Review of relevant mathematics
2) Viscosity and mechanisms of momentum transport

3) Equations of change for isothermal systems
4) Computer simulation of fluid flow

5) Macroscopic balances for isothermal flow systems

Make-up Classes

If necessary, they will be announced ahead of time.

Quizzes

Quizzes will be given during class and will last at least 20 minutes.

Attendance

Attendance at lectures is critical for your mastery of the subject material.

Make-up Exams

Make-up exams will be given with proper justification.

Relationship to ABET Criterion 3

a	b	c	d	e	f	g	h	i	j	k
√	√	√		√		√		√		√

Relationship to Chemical Engineering Program Objectives

1	2	3	4	5
√	√	√	√	

Evaluation/Grading

Quizzes:	20%
Exam 1:	15%

Exam 2:	15%
Exam 3:	15%
Computer Project:	10%
Final Exam:	25%

Academic Misconduct

Academic integrity is absolutely essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. The Ohio State University presumes that all students have read and understand the University's Code of Student Conduct and that all students will complete all academic and scholarly assignments with fairness and honesty. Ignorance of this code is never considered an excuse for academic misconduct. A faculty member who believes that a student has committed academic misconduct is obligated by University Rules to report the student to the Committee on Academic Misconduct (COAM). Any students observing misconduct should report such to the course instructor. If COAM finds that the student has violated the code, then sanctions in the most serious cases could include a failing grade and suspension or dismissal from the University.

The Code of Student Conduct defines Academic Misconduct to include: violation of course rules; providing or receiving information during quizzes or exams; submitting plagiarized work; and falsification, fabrication, or dishonesty in reporting research results.

For additional information, see the Code of Student Conduct
http://studentaffairs.osu.edu/resource_csc.asp

Disabilities

Students with disabilities that have been certified by the Office for Disability Services (ODS) will be appropriately accommodated, and should inform the instructor as soon as possible of their needs.

The ODS offers a wide variety of services to students with documented permanent or temporary disabilities. All types of disability are covered, including physical (mobility, dexterity, endurance, etc.), perceptual, cognitive (attention, distractibility, communication, etc), and behavioral.

If you believe that you may have a disability, please contact the Office of Disability Services as soon as possible so that accommodation may be provided. The Office for Disability Services is located in 150 Pomerene Hall, 1760 Neil Avenue; telephone 292-3307, TDD 292-0901. See their website for detailed information:
http://www.ods.ohio-state.edu/

Preparation

Syllabus prepared by Professor Andre F. Palmer
Last modified: 8/9/2016

Transport Phenomena I

Instructor:

Isamu Kusaka
office: CBEC 512
office hours: TBA, by appointment via e-mail.
e-mail: kusaka.2@osu.edu

TA:

TA	e-mail	office hours
TBA	TBA	TBA

Class Hours and Location: TBA

Textbook: *Transport Phenomena*, revised 2nd edition, by Bird, Stewart, Lightfoot. Wiley (2007). Older 2nd edition (2002) is acceptable, but this edition may contain a small number of typos.

Homework: Currently, 9 assignments are planned. Each assignment and its due date will be posted on Carmen Canvas. The official rules for the homework are as follows:

Submission: Scan or take pictures of your work and upload them on Carmen (Canvas) preferably in pdf format. Please make sure the following

- The images have enough resolution to be legible,
- You include all relevant pages, and
- Work you are submitting is for this course.

Collaboration: Collaboration/discussion among students is encouraged. However, ***the work you turn in must be a product of your own.*** That is, after you work out the solution together, take a time alone to think and write up the solution on your own. *Unreasonably similar papers may be challenged and reported to the Committee on Academic Misconduct (COAM).*

Late assignment: Late assignment should be submitted directly to me, not to a TA. I will accept a late assignment without a penalty ***provided*** that you make an arrangement with me at least 48 hrs in advance of the deadline. A late assignment without such an arrangement will receive 50% reduction of the grade and will not be accepted after 24 hrs of the deadline.

Incomplete assignment: You are strongly encouraged to submit your work when it is due even if it is incomplete rather than receive a penalty for a late submission.

Academic misconduct: Never consult the solution set, whether it is from this or the previous years, before you submit your work. You may seek help only from those who are either teaching or currently in this section of the course. *Any violation of this policy will be reported to COAM.*

Exams:

Format: Exams are given in class with closed notes and books. You may bring a single ***hand written*** cheat sheet to the exam. The sheet should be ***no larger*** than 8.5in×11in in dimension. Feel free to use both sides of the paper.

Regrading: Regrading requests should be made to me, not to a TA. Attach a brief note explaining why you believe regrading is warranted.

Ethical conduct:
Students are expected to follow the Standard for Ethical Conduct established by the The Ohio State University. Any unethical behavior or academic misconduct will be reported to COAM. For details, see the Code of Student Conduct at http://studentconduct.osu.edu/.

Evaluation: Final grades will be based on the components listed.

Components	% of Total
Homework	30 %
Midterm 1	15 %
Midterm 2	15 %
Midterm 3	15 %
Final	25 %
TOTAL	**100%**

Exam schedule:

	Tentative date	Time	Content
Midterm 1	TBA	TBA	Heat transfer with no motion or work (1-dim problems)
Midterm 2	TBA	TBA	Heat transfer with no motion or work (2-dim problems)
Midterm 3	TBA	TBA	Heat transfer with motion and work
Final	TBA	TBA	Comprehensive

Disability Services: Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. Details of the disability services can be found **here**.

Stress Management: Your well-being is important. On course related matters, you should feel free to request a meeting with me to discuss them. A professional service is also available on campus. Details can be found **here**.

Basic Needs Security: You can't learn well on an empty stomach. On that note, any student who faces challenges securing food or housing and believes this may affect their performance in the course is urged to contact:

1. The EHE UGSS and ACES food pantry: PAES Building A100. You can pick up a grocery bag of food and/or a hygiene pack if you are in need of assistance. Office hours are Monday-Friday 8am-5pm, no appointment necessary.
2. Buckeye Food Alliance: Lincoln Tower, 1800 Cannon Dr. Suite 150, 614-688-2508. https://buckeyefoodalliance.org/

3. Student Advocacy Center at The Office of Student Life: 001 Drackett Tower, 191 W. Lane Ave, 614-292-1111

Other resources are

1. Mid Ohio Food Bank:
   https://www.midohiofoodbank.org/get-help/get-food/
2. Kroger Community Pantry:
   https://www.midohiofoodbank.org/get-help/kroger-pantry/
3. Food Pantries.org (This gives you a list of food banks to find one near y ou):
   https://www.foodpantries.org/ci/oh-columbus

Statement on the Office of Institutional Equity (OIE): The Ohio State University is committed to building and maintaining a diverse community to reflect human diversity and improve opportunities for all. The university is committed to equal opportunity, affirmative action, and eliminating harassment and discrimination. The Office of Institutional Equity exists to help the Ohio State community prevent and respond to all forms of harassment, discrimination and sexual misconduct. For more information on OIE, visit **this link** or email **equity@osu.edu**.

Title IX: If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at **this link** or by contacting the Ohio State Title IX Coordinator at **titleix@osu.edu**. Title IX is part of the OIE at Ohio State.

Copyright Disclaimer: The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Announcements: Announcements will be made through Carmen throughout the semester. Please look for them regularly.

Updates/Announcements: This syllabus will be updated as needed. Please consult the most updated version on Carmen course page.

Outline

1. The Mathematics of Transport Phenomena [A very brief review of materials from 420/520]
   (a) Vector/tensor algebra
      i. Addition of two vectors and multiplication of a vector by a number
      ii. The dot product of two vectors
      iii. Heat flux and the heat flux vector
      iv. Stress vector and stress tensor
   (b) Vector/tensor calculus
      i. The "del" operator
      ii. Volume and surface integrals
      iii. The divergence theorem
      iv. The Reynolds transport theorem
2. Heat transfer with no motion or work
   (a) The first law of thermodynamics (Energy balance)
   (b) Constitutive relations (Equation of state and Fourier's "law" of heat conduction)
   (c) A few examples
   (d) Heat transfer from a cylindrical fin
   (e) Solutions of 2nd order ODEs (A brief review)
   (f) Bessel functions
   (g) Unsteady state problems
   (h) Solutions of of PDEs (A brief review)
3. Numerical solutions (Finite difference method)
4. Heat transfer with motion and work
   (a) Mass, Momentum, and energy balance
   (b) Constitutive relations
   (c) Remark on forced convection and free convection
   (d) Viscous heating
   (e) Macroscopic balance equations
5. Dimensional analysis
6. Heat transfer coefficient in forced convection
7. The design of heat exchanger
8. Heat transfer coefficient in free convection

ChBE 3422- Spring Semester 2021

Chemical Engineering Transport Phenomena III – Mass Transfer
M, W, F 8:00 - 8:55 am on-line

Instructor:

Dr. John Clay
Office: 251 CBEC Email: clay.32@osu.edu
Office hours: TBD based on student survey

Teaching Assistants:

Justin Hopkins Email: hopkins.810@osu.edu

Zoom: https://osu.zoom.us/j/2514408530?pwd=RnpFVUlFSEgwdVlYa09EaUpaamtyZz09 (Links to an external site.)

Alec Pellicciotti Email: pellicciotti.1@osu.edu

Zoom: https://osu.zoom.us/j/3735669923?pwd=WUxYSTdxcmJTbWg1MHNKcFlTVGhUUT09 (Links to an external site.)

Nick Sekas Email: sekas.3@osu.edu

Zoom: https://osu.zoom.us/j/4263528564?pwd=SzhVaVR2YmtxRVpHYTJ4eTFqTW16UT09 (Links to an external site.)

TA office hours:

CBE 3422 Schedule – Spring 2023				
Week	Dates	Quizzes/Exams	HW Due	Topics
1		Quiz 0 - Survey	HW 1 – Jan 16	Mass Transfer Basics
2		Quiz 1		Diffusivity; Fick's Law
3		Quiz 2		1D SS mass transfer
4		MT 1		UMD; UCMD
5				Mass transfer with chemical reactions
6		Quiz 3		2D mass transfer
7				Mass transfer coefficients
8		Quiz 4		Convective mass transfer
9				USS mass transfer
10		MT 2		Finite Difference Methods
11				Gumley-Lurie charts
12		Quiz 5		Dimensionless numbers and transport analysis
13		MT 3		MT in staged columns
14		Quiz 6		MT in electrochemical processes
15				Review for final
16	Final			

Prerequisites: CBE 2420 Transport Phenomena I - Momentum Transfer

Textbooks: Fundamentals of Heat and Mass Transfer, Incropera, DeWitt, Bergman, and Lavine

Course description and objectives:
The transport processes involved in heat and mass transfer will be outlined and governing equations derived. All three modes of heat transfer (conduction, convection, and radiation) will be taught in detail. Steady-state and unsteady-state mass transfer will also be taught. The concept and use of mass transfer coefficients and the use of dimensionless numbers will be demonstrated. Practical examples will complement mathematical analysis for the different heat transfer modes. The analogies between heat transfer, mass transfer, and momentum transfer will be summarized.

On completion of this course, you should be able to:

- Describe the three modes of heat transfer and be able to write the empirical laws governing each mode
- Understand the key physical properties governing heat and mass transfer
- Be able to set up shell balances and surface balances for heat and mass transfer problems
- Identify appropriate boundary conditions to solve the governing equations
- Understand and apply the concept of analogies between different transport phenomena
- Apply the finite difference technique to allow numeric solution of heat and mass transfer problems
- Understand the concept and application of key dimensionless numbers in transport
- Identify and apply the appropriate correlation to solve transport problems

Course Policies and Procedures

There are strict policies regarding homework, exams, and attendance. You are responsible for reading and abiding by all of the following information.

Mode of delivery: This course will be taught in a distance learning mode, with lectures taught online using CarmenCanvas and CarmenZoom. The live on-line sessions will be recorded so you can review, but please note the attendance expectations below. We cannot guarantee in-class sessions will be recorded.

Copyright disclaimer: The materials used in connection with this course may be subject to copyright protection and are only for the use of students officially enrolled in the course for

the educational purposes associated with the course. Copyright law must be considered before copying, retaining, or disseminating materials outside of the course.

Attendance: Attendance at all lectures is strongly encouraged. There will be material covered in class that is not in the textbook. Worksheets will also be solved in class by students.

The classroom should be a learning-centered environment in which faculty and students are unhindered by disruptive behavior. You are expected to act in a mature manner and to be respectful of the learning process, your instructor, and your fellow students. Due to the large amount of material covered in this class, attending class and live sessions online is essential to your success. Missing one or two classes can leave you behind, and course material builds on previous work, so it is challenging to catch up. You are expected to attend all class sessions. If you need to miss class, please let your instructor know as soon as possible.

Homework: Homework is a critical component of the course. We are both firm proponents that the best learning in chemical engineering is done by doing lots of problems. We make no excuses for the fact that we give a lot of homework in this class, and we expect students to spend significant time working on the problems. Each student must do and turn in his/her own work. Plagiarism of homework will not be tolerated and will be subjected to academic misconduct punishment.

Homework is self-graded, and to earn full credit students must submit homework online in accordance with the following schedule.

- The initial version of the homework is scanned and uploaded as a single pdf file to the assignment labeled “Homework #X ” by the listed due date.
- Solutions become live as soon as the homework submission due date is passed.
- Students correct their own homework, record the grade at the top of the assignment, and resubmit the corrected homework as a pdf file to the assignment labeled “Graded Homework #X” by the submission due date (~3 days after solutions are made available).
- Corrections receive 50% of the original credit. eg. if you had 5/10 and fixed everything on grading your final score would be 7.5/10.

Weekly assignments are usually assigned by Friday and due the following Friday by 10:59 PM unless otherwise noted. Homework assignments will consist of individual and group assignments.

Homework must be submitted on time to be eligible for full credit. No late problem sets will be accepted without a documented excuse. We will be much more flexible in scheduling make-up work if you contact your Professor prior to missing a deadline. There will be no credit for late unexcused homework. **Note that all homework must be turned in to get a grade for this class, with all assignments due no later than the start of the final exam.** Solution manuals are now readily available for most texts. We have reduced credit for homework in response to this. Quizzes and tests will be very similar to homework problems, so we urge you to minimize the reliance on any available solution manuals and

prior course files. The extra efforts each week will be well worth your time during the quizzes and tests.

Quizzes: Several quizzes will be assigned during the course of the term. Quizzes are typically short problem sets that assess knowledge on a particular topic. Students may bring a single sheet of paper with relevant notes to each scheduled in-class quiz. In addition, some quizzes may be assigned on Carmen. The quizzes are intended to assess student understanding of topics and to identify gaps in knowledge before the exams are administered.

Exams: There will be 3 midterm exams and a Final exam. The dates for midterm and final exams are given in the class schedule. No make-up exam will be given unless you have obtained permission from the instructor beforehand. Exams will be closed book but students may bring a single sheet of paper with relevant notes. The use of any electronic equipment other than a calculator is not allowed during exams. Any attempt to use a wireless communications device of any kind during an exam will be treated as academic misconduct.

The dates for midterm and final exams are given in the class schedule. No make-up exam will be given unless you have obtained permission from the instructor beforehand. If you know that you cannot take the exam on the scheduled date and time, you must discuss with the instructor far in advance.

Regrades: Although extremely rare, the instructor and the TAs have been known to occasionally make mistakes when grading or setting up a solution. If you believe a mistake was made and that you deserve more points on a homework or exam, attach a note to the work with a clear and concise explanation and resubmit to your professor. You must do this within one week after the assignment or exam in question is returned. Assignments and exams resubmitted after one week will not be considered for correction. Exams are randomly and routinely photocopied and if you are caught changing answers then submitting for a regrade, you will be charged with academic misconduct.

Technology

Course Technology: For the online portion of this class, you will need a computer with internet connection, a microphone, webcam, and mobile device (phone or tablet) for BuckeyPass authentication when logging into CarmenCanvas and other OSU resources. We will also use TopHat, a student-response platform. TopHat is site-licensed by OSU and therefore free for students.

To ensure that you are able to connect to Carmen at all times, it is recommended that you take the following steps:

- Register multiple devices in case something happens to your primary device. Visit the BuckeyePass - Adding a Device (Links to an external site.) help article for step-by-step instructions.
- Request passcodes to keep as a backup authentication option. When you see the Duo login screen on your computer, click **Enter a Passcode** and then click

the **Text me new codes** button that appears. This will text you ten passcodes good for 365 days that can each be used once.
- Download the Duo Mobile application (Links to an external site.) to all of your registered devices for the ability to generate one-time codes in the event that you lose cell, data, or Wi-Fi service.
- If none of these options will meet the needs of your situation, you can contact the IT Service Desk at 614-688-4357 (HELP) and IT support staff will work out a solution with you.

Getting Help: For help with your password, University email, CarmenCanvas, or any other technology issues, questions, or requests, contact the Ohio State IT Service Desk. Standard support hours are available at https://ocio.osu.edu/help/hours (Links to an external site.) and support for urgent issues is available 24/7.

- Self service and chat support: https://ocio.osu.edu/help (Links to an external site.)
- Phone: 614-688-4357 (HELP)
- Email: servicedesk@osu.edu (mail to 8help@osu.edu)
- TDD: 614-688-8743
- CarmenCanvas accessibility (https://community.canvaslms.com/docs/DOC-2061 (Links to an external site.))
- CarmenZoom accessibility (https://resourcecenter.odee.osu.edu/carmenzoom/accessibility-carmenzoom (Links to an external site.))

Academic Misconduct

It is the responsibility of the Committee on Academic Misconduct to investigate or establish procedures for the investigation of all reported cases of student academic misconduct.

- All cases of suspected misconduct must be reported to the University Committee on Misconduct (Faculty Rule 3335-5-487). Any students observing misconduct should report such to the course instructor.
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technology solutions (on-line proctoring, plagiarism checks) to verify that students are completing their own work remotely without outside assistance.

For additional information, see the Code of Student Conduct

(http://studentaffairs.osu.edu/info_for_students/csc.asp (Links to an external site.)) and the official Ohio State Academic Misconduct
Code: http://www.osu.edu/offices/oaa/procedures/1.0.html

Statement on Diversity

Diversity is a fundamental part of our profession, valued by our university, college, department, professional organizations, and industry members that hire our students. Many academic studies highlight the importance of diversity in the engineering profession. This peer-reviewed research directly supports the value of working with individuals whose viewpoints are formed by their unique perspective on the world. In this course, you will work in groups. You will do yourself and your group a disservice if you do not fully utilize the resources that each individual provides to the group. Further, I strongly encourage you to consider forming a diverse peer network outside your group to discuss and review course materials. We need all hands on deck to solve the world's challenging engineering problems!

Peer Reviewed Research Highlighting the Importance of Diversity in Engineering

https://www.nap.edu/read/10377/chapter/4 (Links to an external site.)
https://search.informit.com.au/documentSummary;dn=199154901624228;res=IELENG (Links to an external site.)
https://doi.org/10.24908/pceea.v0i0.9486 (Links to an external site.)
https://www.pnas.org/content/117/17/9284 (Links to an external site.)

(and many more!!!)

University and College Resources: The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

https://www.osu.edu/initiatives/diversity.html (Links to an external site.)

https://engineering.osu.edu/diversity (Links to an external site.)

The AIChE states: "We work towards a better future for all — not just through our technical expertise but through how we inspire, engage, retain and advance future talent, and how we treat each other within and beyond the profession…We believe that some groups experiencing historical and present discrimination continue to face specific challenges in entry to or participation in engineering and science professions. AIChE holds forth a vision of the profession in which discrimination and conscious or unconscious bias is unwelcome and unacceptable. Efforts to support and promote diversity must also address root causes of inequities and narrow gaps, not just their manifestations."

https://www.aiche.org/equity-diversity-inclusion/statement (Links to an external site.)

Similarly, ACS recognizes the importance of diversity: "We encourage inclusivity and oppose discrimination in scientific learning and practice based on - but not limited to - race, religion, country or ethnic origin, citizenship, language, political opinion, sex, gender identity and expression, sexual orientation, disability, age, and economic class in academic, industrial, and government workplaces. The Society believes that an enduring commitment to diversity enables excellence, innovation, and transformative action in current and future generations of chemical professionals."

https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html (Links to an external site.)

Title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at **titleix@osu.edu**

Reporting: To report an issue with Title IX or any other form of discrimination (e.g., racial, gender, sexuality, religion), please reach out to me or the department chair Umit Ozkan (ozkan.1@osu.edu). We are committed to an equitable, supportive, and nurturing educational environment.

Disability Services

Requesting accommodations: The university strives to make all learning experiences as accessible as possible. If you anticipate or experience academic barriers based on your disability including mental health, chronic or temporary medical conditions, please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. **SLDS contact information:** slds@osu.edu; 614-292-3307; 098 Baker Hall, 113 W. 12th Avenue.

Accessibility of course technology: This online course requires use of Carmen (Ohio State's learning management system) and other online communication and multimedia tools. If you need additional services to use these technologies, please request accommodations with your instructor.

- CarmenCanvas accessibility (Links to an external site.)
- Streaming audio and video
- CarmenZoom accessibility (Links to an external site.)
- Collaborative course tools

Mental Health Services

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24-hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273--TALK or at suicidepreventionlifeline.org.

Student Emergency Financial Support

The **Student Advocacy Center** staff members are continuing to serve students during normal business hours and are accepting online appointments.

The **Student Emergency Fund** is available to students who may otherwise be at risk of dropping out of college due to an unexpected financial emergency. If you, or a student you know, are experiencing an unplanned expense, the Student Emergency Fund may be an option. Their office is accepting applications and may be able to award up to $1,000 to eligible students. **Learn more and apply** (Links to an external site.).

The Together As Buckeyes emergency grants program, funded primarily by the federal Coronavirus Aid, Relief and Economic Security (CARES) Act, is available to all students — undergraduate, graduate and professional — through the Student Financial Aid office. To apply for a grant, students need to complete a one-page Emergency Request form (Links to an external site.) and provide any supporting documentation. The Office of Student Financial Aid will process applications after determining eligibility based on each student's circumstances and guidance from the U.S. Department of Education.

Franklin County Department of Job and Family Services has amended its Prevention, Retention and Contingency Program to provide targeted relief for families impacted by the COVID-19 pandemic. The Franklin County COVID-19 Response PRC Program provides eligible families with $500 in one-time cash assistance to help address emergent needs and expenses brought about by the public health emergency. Families can apply online (Links to an external site.) today.

The **Student Wellness Center** offers financial coaching through the Scarlet and Gray Financial nationally recognized peer financial coaching program. Through the program, students will learn about financial goal setting, banking basics, budgeting, credit education, debt repayment education and saving and retirement education. Learn more (Links to an external site.).

Food Assistance

It's a common idea that pervades American culture: when you're in college, it's simply a rite of passage to sustain yourself on cheap, unhealthy food. We disagree. We highly recommend OSU's **Buckeye Food Alliance** Lincoln Tower 150 food pantry (https://www.buckeyefoodalliance.org (Links to an external site.)) and the MidOhio Foodbank (https://www.midohiofoodbank.org (Links to an external site.)). The **Buckeye Food Alliance** will remain open to support students in need. Starting Monday, March 23 the pantry will be open Monday/Thursday 10 a.m. – 2 p.m.; Tuesday/Wednesday 4 – 8 p.m. and Friday 11 a.m. – 3 p.m. If these times do not work for your schedule, you can schedule a special appointment by contacting Nick Fowler at fowler.318@osu.edu.

CBE 3508

Chemical Engineering Thermodynamics 1

Instructor: to be determined

Teaching Assistants: to be determined

Office hours: to be determined

Prerequisites: CBE 2420 and enrollment in CBE, FABEng, or EngPhysics major; or permission of instructor.

Textbook: *Chemical, Biochemical, and Engineering Thermodynamics*, 5th Edition, by Stanley I. Sandler

Course description: This course focuses on the development of the conceptual basis for thermodynamics: energy conservation in open and closed systems (first thermodynamic law), temperature, entropy and reversibility (second thermodynamic law), fundamental equations, and criteria of equilibrium and stability. Engineering is a problem-solving profession and in this course we will draw upon your knowledge of chemistry, math, and physics to develop problem-solving skills to be used throughout all the CBE curriculum.

Objectives:
Upon completion of this course, a student should be able to:

a. Understand the fundamental basis of the first and second laws of thermodynamics.
b. Be familiar with various thermodynamic identities.
c. Estimate thermodynamic properties of pure gases and liquids using equations of state.
d. Develop mass and energy balance equations necessary to solve non-reactive steady-state and transient systems by hand or by computer using process simulation software.
e. Use tables, charts, or software to estimate physical property data needed to solve material and energy balances.
f. Calculate fugacity in nonideal solutions.
g. Determine whether a system has attained equilibrium.

Coverage of Topics:

Introduction; Equilibrium states; State Variables; Work and Energy	Sandler Sec. 1.1-1.6
Conservation of Mass	Sandler Sec. 2.1-2.2
Conservation of Energy (1^{st} law)	Sandler 3.1-3.2
Thermodynamic Properties of Matter	Sandler 3.3-3.4
Applications of the 1^{st} law	
Entropy; 2^{nd} law	Sandler 4.1-4.2
Reversibility; Max/Min Work; Finding DS	Sandler 4.3-4.4

Applications of the 2nd law	Sandler 4.5
Heat Engines; Carnot cycle	Sandler 4.3
Power generation and Refrigeration Cycles	Sandler 5.1-5.2
Thermodynamics of Mechanical Explosions (optional)	Sandler 5.3
Partial Derivatives & Maxwell Relations	Sandler 6.1-6.2
Properties of Real Fluids; Equation of State	Sandler 6.4-6.7
Finding DU, DH, DS for real fluids (Matlab)	
Equilibrium & Stability criteria	Sandler 7.1-7.2
Phase Equilibria; Fugacity	Sandler 7.3-7.4
Phase Transitions	Sandler 7.7
Pure vapor-liquid phase equilibrium (Matlab); Gibbs Phase Rule	Sandler 7.5-7.6

Course requirements:
Homework: Weekly homework assignments are usually given on Thursday and are due on the following Thursday when class starts. Homework must be submitted on time to be eligible for full credit unless there is a documented excuse. Late homework should still be completed and submitted but will result in a score of 0 for that assignment. **All homework must be turned in prior to the final to receive a grade for this class.**

Exams:
There will be 2 midterm exams and a Final exam. The dates for midterm and final exams are given in the class schedule. No make-up exam will be given unless you have obtained permission from the instructor beforehand. If you know that you cannot take the exam on the scheduled date and time, you must discuss with the instructor about the possibility to take the exam earlier. Exams will be closed book and closed notes. This does not mean you should relax your studying based on the crutch of having notes. The use of any electronic equipment other than a calculator is not allowed during exams. **Any attempt to use a wireless communications device of any kind during an exam will be treated as academic misconduct.**
Makeup Policy: No makeup quizzes or exams will be given. A student with a ***documented excuse for an absence*** will be given a score for the missed quiz (exam) equal to the average of the remaining quizzes and exams (including the final) in the class.

Grades:
Homework - 20%, Quizzes - 15%, 2 Midterm Exams - 40% (2 x 20% each), Final Exam - 25%
The tentative distribution used to determine final letter grades will be:

A- (>=90%), B- (>=80%), C- (>=70%), D (>=60%).

These ranges may be relaxed somewhat at the end of the quarter (curved), but you are guaranteed of receiving at least the grade as listed above.

Course Policies: There are strict policies regarding homework, exams, and attendance. You are responsible for reading all of the following information. **Quizzes:** There will be approximately eight (8) quizzes given over the course of the semester. These are typically short (10-25 minute) rapid assessments. The main purpose of quizzes is to determine your readiness for the higher-weighted exams. Pop quizzes will be administered, rewarding those who are present in lecture.

Homework: Homework is a critical component of the course. I am a firm proponent that the best learning in chemical engineering is done by doing lots of problems. I make no excuses for the fact that I give a lot of homework in this class, and I expect students to spend significant time working on

the problems. Each student must do and turn in his/her own work. Plagiarism of homework will not be tolerated and will be subjected to academic misconduct punishment.

Attendance: Attendance at all lectures is strongly encouraged. There will be material covered in class that is not in the textbook. Worksheets will also be solved in class by students. Attendance will be taken periodically. Pop quizzes have been known to be assigned when the number of students falls too low. Due to the large amount of material covered in this class, attending class and live sessions online is essential to your success. Missing one or two classes can leave you behind, and course material builds on previous work, so it is challenging to catch up. You are expected to attend all class sessions. If you need to miss class, please let me know as soon as possible.

Regrades:
Although extremely rare, the instructor and the TAs have been known to occasionally make mistakes when grading. If you believe a mistake was made and that you deserve more points on a homework or exam, **attach a note to the work with a clear and concise explanation** and resubmit to the professor. You must do this **within one week after the assignment or exam in question is returned**. Assignments and exams resubmitted after one week will not be considered for correction. Exams are randomly and routinely photocopied and if you are caught changing answers then submitting for a regrade, you will be charged with academic misconduct.

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can arrange interim measures, provide support resources, and explain investigation options, including referral to confidential resources.
If you or someone you know has been harassed or discriminated against based on your sex or gender, including sexual harassment, sexual assault, relationship violence, stalking, or sexual exploitation, you may find information about your rights and options at titleix.osu.edu or by contacting the Ohio State Title IX Coordinator at titleix@osu.edu. Title IX is part of the Office of Institutional Equity (OIE) at Ohio State, which responds to all bias-motivated incidents of harassment and discrimination, such as race, religion, national origin and disability. For more information on OIE, visit equity.osu.edu or email equity@osu.edu.

Diversity Statement: I consider the classroom and laboratory to be places where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and all other visible and nonvisible differences. All members of this class are expected to contribute in a respectful, welcoming, and inclusive environment for every other member of the class.

Mental Health Services:
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on-call counselor when CCS is closed at 614-292-5766 and 24-hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273--TALK or at suicidepreventionlifeline.org.

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CBE 3509

Chemical Engineering Thermodynamics 2

Instructor: to be determined

Teaching Assistants: to be determined

Office hours: to be determined

Prerequisites: CBE 3508 and enrollment in CBE, FABEng, or EngPhysics major; or permission of instructor.

Textbook: *Chemical, Biochemical, and Engineering Thermodynamics*, 5th Edition, by Stanley I. Sandler

Course description: This course focuses on the use of thermodynamics concepts to analyze systems or processes including energy conversion processes, reactions, and properties of mixtures, e.g., obtaining the equilibrium composition of coexisting phases. Engineering is a problem-solving profession and in this course we will draw upon your knowledge of chemistry, math, and physics to develop problem-solving skills to be used throughout all the CBE curriculum.

Objectives:
Upon completion of this course, a student should be able to:

a. Have mastered the application of the first and second laws of thermodynamics.
b. Apply pertinent mathematical concepts required to develop general thermodynamic equations of change.
c. Understand concepts of phase equilibrium, stability, reversible and irreversible processes.
d. Use equations of state and activity coefficient models (by hand or using software) to describe multicomponent phase equilibria (we'll focus primarily on vapor-liquid equilibrium.
e. Determine reaction equilibrium constants and predict effects of temperature, pressure, and composition on equilibrium conversion.

Coverage of Topics:

Review Equilibrium criteria; fugacity and pure component VLE	Sandler Chp. 7.1-7.4
Thermodynamic of Mixtures	Sandler 8.1
Partial Molar Properties; Gibbs-Duhem	Sandler 8.2
Experimental measurement of partial molar properties	Sandler 8.6
Criteria for phase equil for multicomponent; Gibbs Phase Rule	Sandler 8.7, 8.9
Ideal gas mixtures and Ideal mixtures	Sandler 9.1, 9.3
Calculating fugacity for gas, liquid, solid mixtures	Sandler 9.2, 9.4

Activity coefficient models (Matlab)	Sandler 9.5, 9.6
Vapor-Liquid Equilibrium (VLE)	Sandler 10.1, 10.2
VLE with cubic EOS (Matlab)	Sandler 10.3
Gas Solubilities in liquids	Sandler 11.1
Liquid-Liquid Equilibrium	Sandler 11.2
Vapor-Liquid-Liquid Equilibrium	Sandler 11.3
Solid-Liquid equilibrium	Sandler 12.1
Freezing Point Depression	Sandler 12.3
Osmotic Equil & Pressure	Sandler 11.5
Phase Behavior of Solid Mixtures	Sandler 12.4
Chemical Equil in a single phase	Sandler 8.3-8.5, 13.1
Heterogenous Chemical Reactions	Sandler 13.2
Multiple Chemical Reactions	Sandler 13.3
Chemical Reactions and Phase equilibria	Sandler 13.4
Additional Topics: Electrochemical reactions or biochemical applications	

Course requirements:
Homework: Weekly homework assignments are usually given on Thursday and are due on the following Thursday when class starts. Homework must be submitted on time to be eligible for full credit unless there is a documented excuse. Late homework should still be completed and submitted but will result in a score of 0 for that assignment. **All homework must be turned in prior to the final to receive a grade for this class.**

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CBE 3610: Kinetics and Reactor Design (Autumn 2019)

	Time	Location
Lecture:	M T W R (5:20-6:15 PM)	HI 324

Instructor:	Nicholas Brunelli	**Office:** 253 CBEC **Email:** Brunelli.2@osu.edu **Office Hours:** TBA **Online:** Saturday - Monday **(**~ 9:00 pm)
Teaching Assistant:	Melanie Gross	**Email:** gross.530@osu.edu **Office Hours:** **TBA**
	McKenzie Martin	**Email:** martin.3321@osu.edu **Office Hours:** **TBA**
	Alex Spanos	**Email:** spanos.12@osu.edu **Office Hours:** **TBA**
	Brian Veitch	**Email:** veitch.8@osu.edu **Office Hours:** **TBA**

Course Description

The heart of chemical engineering technology is the reactor. Chemical reactors are used to convert starting materials into valuable products and waste streams into benign components. These reactions often involve complex reaction networks that can be analyzed using kinetic models to design reactors for laboratory and commercial scale processes. While these methods will be developed in the context of industrially important reactions, the methods are powerful and can be applied to many systems from biological systems to the atmosphere.

Website:

Carmen will have all homework assignments posted and the solution keys for homework. Other downloads of documents and announcements will also be found on Carmen, including the power point slides for lectures. Updates to the syllabus and schedule will be posted on Carmen and it is your responsibility to ensure that you are aware of the latest schedule.

Text

Encouraged: *Chemical Reactor Analysis and Design Fundamentals*, James B. Rawlings and John G Ekerdt, Prentice Hall, 2nd Edition. 2013, ISBN 978-0-9759377-2-3 (Required reading)
Note: The exams will be open book – if you have an electronic version, it is your responsibility to print the necessary pages or find a hard copy.

Course Objectives

Upon completion of this course, a student should be able to:

a. Use reaction equations, rate laws, and stoichiometry to balance elements in reactors.
b. Understand criteria for chemical equilibrium.
c. Design simple isothermal and non-isothermal chemical reactors.
d. Apply combined material and energy balances in batch, CSTR, PFR reactors.
e. Analyze multivariable data and apply mathematical tools for solving multiple differential and/or algebraic equations.
f. Work ethically with other students, engaging in discussions and working independently as appropriate.

Grading

Individual Problem Sets – Self-Graded (15%):

Individual problem sets will be assigned most weeks. Students may work together, but each must submit her/his own assignment, written in her/his own words. Students will be required to upload a copy of the solution to the dropbox account of Carmen by 11:59 pm of the day that the assignment is due. The solutions with point value assignments identified will be released the following day so that students need to grade their own assignments and submit a score for that assignment within seven (7) days. Students must submit a regrade to receive any points.

In addition, students will be eligible to receive credit for 50% of the points missed on the assignment through uploading to dropbox a corrected version of the homework three (3) days after the original assignment was due. **Students must submit an assignment with work to be eligible to receive points back.** The student is responsible for checking that the assignment uploaded correctly.

No late problem sets will be accepted without a documented excuse. Late assignments (original submission) will only be eligible for 25% of the total points. Late re-grades will be penalized one (1) point per day late. Grades for late assignments will not be posted until the end of the semester. The lowest score will automatically be dropped.

Assignments should be written neatly with answers clearly indicated. TAs will check a portion of the assignments for grading accuracy. Grades will generally be posted in Carmen after the assignment due date. Scores for late assignments will not be posted until the end of the semester.

Exams (85%): There will be **two exams** (30% each) and a final. The exams will take place **during class**. Makeup exams will not be given. Students with an excused absence (e.g., a note indicating visit to medical center) will receive the average score from the other two exams. Note exam dates on schedule are tentative – it is the student's responsibility to be aware of any changes to the exam schedule. **Exams will be open book and closed notes.** It is the student's responsibility to bring a calculator and a hard copy of the book to the exams.

Individual Problem Sets	15%
Exams (2)	50% (25% each)
Final	35%

Regrading Exams & Problem Sets: All requests for re-grades must be made in a written format. If you have questions about the grading, you can talk with the TAs to get clarification and all submission for re-grades of homework should be made to the TAs. You have 1 week after you receive the graded problem set for resubmission. **Accounting errors on exams should be brought to my attention within one week of receiving the graded exam.** *If you believe an exam problem was graded incorrectly, write a short statement making your case and present it to me (not the TAs).*

Grading Scale: A minimum scale is in place such that >90% will guarantee a grade no lower than A-, >80% = B-, >70%=C-, >60%=D. This scale may be relaxed somewhat at the end of the semester, but you are guaranteed of receiving at least the grade listed here.

Students are expected to follow the Standard for Ethical Conduct established by The Ohio State University. Any unethical behavior or academic misconduct will be reported to the University Committee on Misconduct. Students who observe misconduct should report such to the course instructor. At a minimum, a non-passing letter grade will be assigned to students who violate academic honesty standards, regardless of the violator's performance on exams, quizzes, and homework assignments. There is a possibility of expulsion from the department and/or from the university. Note: It is also your responsibility to make a reasonable effort to prevent others from copying from your work. Two exams/quizzes that look similar logically suggest a conspiracy to cheat – I will report such cases to the Committee on Academic Misconduct to investigate. Best policy is to follow the proctor's directions (leave room between yourself and others; move if requested) and to reasonably protect your paper from roving eyes.

Disability Services
Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated and should inform the instructor ***as soon as possible of their needs.*** The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Avenue; telephone 292-3307, TDD 292-0901; http://www.ods.ohio-state.edu/.

Student Counseling
As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce a student's ability to participate in daily activities. The Ohio State University offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the **Office of Student Life's Counseling and Consultation Service (CCS) by visiting ccs.osu.edu or calling 614--292--5766. CCS is located on the 4th Floor of the Younkin Success Center and 10th Floor of Lincoln Tower. You can reach an on call counselor when CCS is closed at 614--292--5766 and 24 hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1--800--273--TALK or at suicidepreventionlifeline.org.**

Food Security and Hunger
15% of OSU students self-report being food insecure. Please take advantage of resources available to you, or if you are able donate or volunteer:
Buckeye Food Alliance: https://www.buckeyefoodalliance.org/.
HandsOn, Central Ohio (A network of pantries and emergency food delivery): https://handsoncentralohio.org/locate-services/food-security/
Mid Ohio Food Bank: https://www.midohiofoodbank.org/get-help/get-food/
Kroger Community Pantry: https://www.midohiofoodbank.org/get-help/kroger-pantry/
Food Pantries.org (This gives you a list of food banks to find one near you): https://www.foodpantries.org/ci/oh-columbus

Letters of Recommendation

Please submit requests for letters of recommendation two (2) weeks in advance of the deadline. Please include a CV. As with all letter requests, it is best to ask someone that can provide details.

Tentative Schedule: Updates will be posted on Carmen

Week	Date	Topics	Reading
1	8/20 (T) – 8/22	• Introduction • Background on chemical reactors and reactions • Chemical reaction stoichiometry • Stoichiometry matrix (linear algebra)	Sec. 1.1-1.5 Sec 2.1-2.3
2	8/26-8/29	• Linearly independent reactions • Maximal set of reactions Reaction rates • Production rates	Sec. 2.4-2.6
3	9/3(T)-9/5	• Computational aspects of stoichiometry • Multiple reactions	Sec. 3.1,3.2,3.5
4	9/09-9/12	• General mole balances • Batch reactors • Simple rate laws – mass action kinetics	Sec. 4.1 – 4.3
5	9/16-9/19	• CSTR • Semi-batch Plug flow reactors (PFR)	Sec. 4.4 – 4.7
6	9/23-9/26	• Non-constant density batch reactor • Non-constant density CSTR/PFR	Sec. 5.1 – 5.2
	9/30	Exam #1	
7	09/30-10/03	• Elementary reactions • Elementary reaction kinetics	Sec. 5.3 – 5.4.2
8	10/07-10/09	• Molecular theories of kinetics • Reaction equilibrium assumption (REA)	Sec. 5.6
	10/10	Fall Break	
9	10/14-10/17	• Quasi-steady state assumption (QSSA) • Enzyme Catalysis	Sec 6.1 – 6.2
10	10/21-10/24	• Reactions on Surfaces • General energy balance	Sec. 6.3 – 6.4
11	10/28-10/31	• Application of combined balances to batch reactors • CSTR – dynamic and steady state operation • CSTR – steady state multiplicity	Sec. 6.5-6.6
	11/04	Exam #2	
12	11/04-11/07	• CSTR – reactor stability • Semi-batch reactor	
	11/11	Veteran's Day	
13	11/12-11/14	• PFR – energy balances	
14	11/18-11/21	• Application of kinetics to other systems •	
15	11/25-11/26	• Reactor mixing	
15	11/27-11/29	Thanksgiving	
16	12/2-12/4	• Final exam review	
Final Exam – Friday (12/06/2019) at 6:00 – 7:45 pm			

Course Syllabus

Jump to Today

CBE 3730 Unit Operations – Spring 2021

Instructor:

Description

The fundamental laboratory course in chemical engineering: laboratory investigation of the operating characteristics of chemical engineering equipment that are related to Transport. Students work in teams of four or five, performing two experiments during the semester. Each team must prepare written reports for two experiments.

Learning Objectives

After completing the course, students will be able to:

Design and conduct laboratory experiments.

- Compare experimentally measured results with literature data and quantify the sources of error that contribute to differences between measured data and literature data.
- Prepare high quality written technical reports and oral presentations to summarize a project in a professional and informative manner.
- Work effectively as a member of a team, both as a team member and as a team leader.
- Work safely in a laboratory by carrying out Safe Operating Procedures, using Personal Protective Equipment properly and consistently, and by properly handling, storing, and disposing of chemicals.

Reference Texts

No textbook is required for this course, but the following may be helpful:
Pocket Book of Technical Writing for Engineers and Scientists, McGraw-Hill by Leo Finkelstein *Transport Processes and Separation Process Principles*, Prentice-Hall by Christie Geankoplis

Required Technology

Device capable of accessing Canvas and Zoom (please connect with both audio and video whenever possible), access to JMP and ChemCAD (https://ets.osu.edu/software (https://ets.osu.edu/software)), access to Overleaf or Microsoft Word for report writing (Overleaf is preferred, you can create a free account at https://www.overleaf.com/ (https://www.overleaf.com/)). All of these are available to CBE students for free.

Documents, Instruction, and Materials

The front page of the Canvas course includes links to all of the course content: lecture videos, experiment operating procedures, Canvas quizzes, group member evaluations, report guidelines, presentation guidelines, grading rubrics etc.

Communication

E-mail is the best way to correspond with the instructors and teaching assistants. Check your university e-mail account daily (name.#@osu.edu) so that you receive any Canvas announcements -- course information will primarily be communicated via Canvas announcements. Office hours for the TAs are by appointment.

Course Delivery and Attendance

Lecture:

The lecture component of this course is delivered entirely online. Pre-recorded lectures are posted weekly via Canvas Modules; you must complete each module before the deadline (7 days after posting) to receive credit for viewing the lecture. The two exams (Canvas quizzes) take place during the scheduled lecture time.

Lab:

The laboratory component of the course is delivered partially online and partially in-person.
First-time students are required to complete the Lab Safety Training Canvas Module. Any first-time student who does not complete the safety training module will not be permitted to conduct experiments in the lab and will receive zeros on all assignments related to the laboratory portion of the course.
There are a number of times when attendance is mandatory:

- Two times each semester: pre-lab meeting with TA – Zoom meeting
- Two times each semester: 2-hr laboratory sessions – in-person
- Two times each semester: 2-hr online lab sessions – Zoom meeting

Lab dates are assigned by the instructor at the end of the first week of the semester. A link to the lab schedule will be posted on the course front page.
Your group leader is responsible for contacting the TA to arrange a pre-lab meeting in advance of your scheduled lab date. The pre-lab meeting should take place at least 1 day before your scheduled lab date, but 2-3 days beforehand is recommended. Failure by the group leader to arrange the pre-lab meeting with the TA will result in a 10 points deduction from the total course grade for the group leader.
Any student who fails to attend the pre-lab meeting with the TA without prior permission from the instructor is considered unqualified to safely operate the laboratory equipment, will not be permitted to participate in the laboratory session, and will receive a zero for all assignments related to that experiment.

Assignment Details and Submission

Details about how and when to submit each assignment are included on the Canvas page for that assignment, which can be accessed by clicking the link on the course front page.

Grading

Regrades

If you believe a mistake was made in grading and that you deserve more points on assignments, lab reports, or exams, send a short note of explanation to the instructor within one week of receiving the grade. Assignments resubmitted after one week will not be considered for correction.

Additional information about grading

Groups often report that one or more group members have not contributed sufficiently to the report, have been unreachable or slow to communicate with the group, or have failed to attend scheduled group meetings. Or, the work contributed by one group member may be below the minimum acceptable level of quality or effort. At the instructor’s discretion, a grade penalty may be assessed to one or more group members. In this case, the penalty may range from 25-100% of the report grade or presentation grade.

Unprofessional or substandard reports will be returned to the group. The group will have two days to rewrite and resubmit the report. The grade for the resubmitted report will be based on a maximum grade of 75%.

Daily deduction for overdue reports: (for each day or fraction thereof) 30% deduction from the group leader's lab report grade, 20% deduction from lab report grade of other group members.

The performance grade of each team member by the group leader should be based on each group member's performance during the experiment and during the report writing.

The performance evaluation by the TA is based on the laboratory performance and on the professionalism in communications / interactions with each group member. It is expected that your full attention will be on the experiment you are conducting. Do not use a cellphone, computer, or tablet for personal (non-course-related) activities during lab. If you are unwilling to participate in lab activities, you may receive a zero for all assignments related to the experiment.

Any intentional or malicious violation of safety rules will result in immediate dismissal from the course. Points may be deducted for minor safety violations during the laboratory experiment at the instructor’s discretion.

Points may be deducted from the total course grade for tardiness when attending lab sessions at the instructor’s discretion. Failure to attend a required lab session without an excused absence will result in a zero for all assignments related to that experiment.

Allowable excused absences include: job interview, bereavement, illness (with doctor's note), military commitments, legal commitments (jury duty, court date), and family emergencies (approved on a case-by-case basis), when requested and approved in advance. Students who miss an in-class exam with an excused absence approved in advance will be permitted to take make-up exam at another time with no penalty. Students who miss an in-class exam without an excused absence approved in advance may or may not be permitted to make-up the exam with a 20% grade penalty at the instructor's discretion.

Course Grade Breakdown

	Points each	Number	Group or Individual Grade	Total
Reports	80	2	G	160
EHS Training	10	1	I	10
Group leader / member evaluations	5	2	I	15
TA evaluation	10	2	I	30
Group assignment survey	5	1	I	5
Ethics case study	20	1	G	20
Completion of lecture modules	30	1	I	30
In-class exams	85	2	I	170
Safety training quiz	20	1	I	20
			Individual	280
			Group	180
			Total	**460**

Academic Misconduct

- It is the responsibility of the Committee on Academic Misconduct (COAM) to investigate all suspected cases of student academic misconduct.
- The Code of Student Conduct defines Academic Misconduct to include: violation of course rules; providing or receiving information during quizzes or exams; submitting plagiarized work; and falsification, fabrication, or dishonesty in reporting research results.
- Report suspected academic misconduct to the course instructor.

- Faculty are required to report all suspected academic misconduct cases to COAM.
- For additional information, see the Code of Student Conduct (https://studentlife.osu.edu/csc/) and the official COAM Procedures and Rules (https://oaa.osu.edu/coam-procedures-and-rules.html (https://oaa.osu.edu/coam-procedures-and-rules.html))

Special considerations for online / electronic assignments and exams:

- Collaboration among students is encouraged. However, work turned in by an individual or group must be the work of that individual or group.
- Possessing or using any part of another group's lab report (hard copy or digital) is academic misconduct. Lab reports are submitted electronically and checked for plagiarism using plagiarism-checking software.
- It is academic misconduct to receive help from any person while taking an online exam, collaborate with any person, provide help to any student, discuss the exam with any student, or capture, save, or disseminate any portion of the exam at any time. Your score / performance on exams must be representative of your own knowledge and ability.
- You are required to agree to an academic misconduct statement on each exam.

The use of proctoring software (e.g. Proctorio) is NOT required for exams, but a number of strategies are in place to deter cheating:

- There are multiple versions of each exam question, randomly selected for each student
- Exam questions appear in a random order for each student
- Multiple choice answers appear in a random order for each student
- Browser activity is logged in Canvas (e.g. time stamps are recorded when navigating away from the exam, selecting an answer, etc.) so collaboration between students is easily detectable.

Disability Services

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Ave; telephone 614-292-3307, VRS: 614-429-1334; http://www.ods.ohio-state.edu/ (Links to an external site.) (http://www.ods.ohio-state.edu/) .

Diversity

Diversity is a fundamental part of our profession, valued by our university, college, department, professional organizations, and industry members that hire our students. Many academic studies highlight the importance of diversity in the engineering profession. This peer-reviewed research directly supports the value of working with individuals whose viewpoints are formed by their unique perspective on the world. In this course, you will work in

groups. You will do yourself and your group a disservice if you do not fully utilize the resources that each individual provides to the group. Further, I strongly encourage you to consider forming a diverse peer network outside your group to discuss and review course materials. We need all hands on deck to solve the world's challenging engineering problems!

Peer Reviewed Research Highlighting the Importance of Diversity in Engineering

https://www.nap.edu/read/10377/chapter/4 (https://www.nap.edu/read/10377/chapter/4)

https://search.informit.com.au/documentSummary;dn=199154901624228;res=IELENG (https://search.informit.com.au/documentSummary;dn=199154901624228;res=IELENG)

https://doi.org/10.24908/pceea.v0i0.9486 (https://doi.org/10.24908/pceea.v0i0.9486)

https://www.pnas.org/content/117/17/9284 (https://www.pnas.org/content/117/17/9284)

(and many more!!!)

University and College Resources:

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

https://www.osu.edu/initiatives/diversity.html (https://www.osu.edu/initiatives/diversity.html)

https://engineering.osu.edu/diversity (https://engineering.osu.edu/diversity)

The AIChE states:

“We work towards a better future for all — not just through our technical expertise but through how we inspire, engage, retain and advance future talent, and how we treat each other within and beyond the profession…We believe that some groups experiencing historical and present discrimination continue to face specific challenges in entry to or participation in engineering and science professions. AIChE holds forth a vision of the profession in which discrimination and conscious or unconscious bias is unwelcome and unacceptable. Efforts to support and promote diversity must also address root causes of inequities and narrow gaps, not just their manifestations.”

https://www.aiche.org/equity-diversity-inclusion/statement (https://www.aiche.org/equity-diversity-inclusion/statement)

Similarly, ACS recognizes the importance of diversity:

“We encourage inclusivity and oppose discrimination in scientific learning and practice based on - but not limited to - race, religion, country or ethnic origin, citizenship, language, political opinion, sex, gender identity and expression, sexual orientation, disability, age, and economic class in academic, industrial, and government workplaces. The Society believes that an enduring commitment to diversity enables excellence, innovation, and

transformative action in current and future generations of chemical professionals."

https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html (https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html)

Title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu (mailto:titleix@osu.edu)

Reporting

To report an issue with Title IX or any other form of discrimination (e.g., racial, gender, sexuality, religion), please reach out to me or the department chair Umit Ozkan (ozkan.1@osu.edu (mailto:ozkan.1@osu.edu)). We are committed to an equitable, supportive, and nurturing educational environment.

Counseling and Consultation Service

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce your ability to participate in daily activities. The university offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting **ccs.osu.edu** or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center at 1640 Neil Avenue and also at 1030 Lincoln Tower, 1800 Cannon Drive. You can reach an on call counselor when CCS is closed by calling 614-292-5766. 24-hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-8255 or at suicidepreventionlifeline.org.

Keep in mind that CCS is not intended to handle every type of problem. They use a triage system that prioritizes students with the most urgent needs. Please check out the mental health resources handout (https://osu.instructure.com/files/27977789/download?download_frd=1) provided in the course files section on Canvas for other options. Also, consider participating in the events organized by the CBE Wellness Committee. Dr. Maxson is the chair of that committee.

Preparation

Last modified: January 13, 2021 by Prof. Maxson

The instructor may make changes to this or any other class document at any time. Always check Canvas for the newest version of any document.

Course Syllabus

Jump to Today

CBE 3731 Unit Operations – Spring 2021

Instructor:

Description

The fundamental laboratory course in chemical engineering: laboratory investigation of the operating characteristics of chemical engineering equipment that are related to Kinetics. Students work in teams of four or five, performing two experiments during the semester. Each team must prepare written reports for two experiments.

Learning Objectives

After completing the course, students will be able to:

Design and conduct laboratory experiments.

- Compare experimentally measured results with literature data and quantify the sources of error that contribute to differences between measured data and literature data.
- Prepare high quality written technical reports and oral presentations to summarize a project in a professional and informative manner.
- Work effectively as a member of a team, both as a team member and as a team leader.
- Work safely in a laboratory by carrying out Safe Operating Procedures, using Personal Protective Equipment properly and consistently, and by properly handling, storing, and disposing of chemicals.

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Required Technology

Device capable of accessing Canvas and Zoom (please connect with both audio and video whenever possible), access to JMP and ChemCAD (https://ets.osu.edu/software (https://ets.osu.edu/software)), access to Overleaf or Microsoft Word for report writing (Overleaf is preferred, you can create a free account at https://www.overleaf.com/ (https://www.overleaf.com/)). All of these are available to CBE students for free.

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Assignment Details and Submission

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Regrades

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Course Grade Breakdown

	Points each	Number	Group or Individual Grade	Total
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TA evaluation	10	2	I	30
Group assignment survey	5	1	I	5
Ethics case study	20	1	G	20
Completion of lecture modules	30	1	I	30
In-class exams	85	2	I	170
Safety training quiz	20	1	I	20
			Individual	280
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Academic Misconduct

- It is the responsibility of the Committee on Academic Misconduct (COAM) to investigate all suspected cases of student academic misconduct.
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- Multiple choice answers appear in a random order for each student
- Browser activity is logged in Canvas (e.g. time stamps are recorded when navigating away from the exam, selecting an answer, etc.) so collaboration between students is easily detectable.

Disability Services

Students with disabilities that have been certified by the Office for Disability Services will be appropriately accommodated, and should inform the instructor as soon as possible of their needs. The Office for Disability Services is located in 098 Baker Hall, 113 W. 12th Ave; telephone 614-292-3307, VRS: 614-429-1334; http://www.ods.ohio-state.edu/ (Links to an external site.) (http://www.ods.ohio-state.edu/) .

Diversity

Diversity is a fundamental part of our profession, valued by our university, college, department, professional organizations, and industry members that hire our students. Many academic studies highlight the importance of diversity in the engineering profession. This peer-reviewed research directly supports the value of working with individuals whose viewpoints are formed by their unique perspective on the world. In this course, you will work in

groups. You will do yourself and your group a disservice if you do not fully utilize the resources that each individual provides to the group. Further, I strongly encourage you to consider forming a diverse peer network outside your group to discuss and review course materials. We need all hands on deck to solve the world's challenging engineering problems!

Peer Reviewed Research Highlighting the Importance of Diversity in Engineering

https://www.nap.edu/read/10377/chapter/4 (https://www.nap.edu/read/10377/chapter/4)

https://search.informit.com.au/documentSummary;dn=199154901624228;res=IELENG (https://search.informit.com.au/documentSummary;dn=199154901624228;res=IELENG)

https://doi.org/10.24908/pceea.v0i0.9486 (https://doi.org/10.24908/pceea.v0i0.9486)

https://www.pnas.org/content/117/17/9284 (https://www.pnas.org/content/117/17/9284)

(and many more!!!)

University and College Resources:

The Ohio State University affirms the importance and value of diversity in the student body. Our programs and curricula reflect our multicultural society and global economy and seek to provide opportunities for students to learn more about persons who are different from them. We are committed to maintaining a community that recognizes and values the inherent worth and dignity of every person; fosters sensitivity, understanding, and mutual respect among each member of our community; and encourages each individual to strive to reach his or her own potential. Discrimination against any individual based upon protected status, which is defined as age, color, disability, gender identity or expression, national origin, race, religion, sex, sexual orientation, or veteran status, is prohibited.

https://www.osu.edu/initiatives/diversity.html (https://www.osu.edu/initiatives/diversity.html)

https://engineering.osu.edu/diversity (https://engineering.osu.edu/diversity)

The AIChE states:

“We work towards a better future for all — not just through our technical expertise but through how we inspire, engage, retain and advance future talent, and how we treat each other within and beyond the profession…We believe that some groups experiencing historical and present discrimination continue to face specific challenges in entry to or participation in engineering and science professions. AIChE holds forth a vision of the profession in which discrimination and conscious or unconscious bias is unwelcome and unacceptable. Efforts to support and promote diversity must also address root causes of inequities and narrow gaps, not just their manifestations.”

https://www.aiche.org/equity-diversity-inclusion/statement (https://www.aiche.org/equity-diversity-inclusion/statement)

Similarly, ACS recognizes the importance of diversity:

“We encourage inclusivity and oppose discrimination in scientific learning and practice based on - but not limited to - race, religion, country or ethnic origin, citizenship, language, political opinion, sex, gender identity and expression, sexual orientation, disability, age, and economic class in academic, industrial, and government workplaces. The Society believes that an enduring commitment to diversity enables excellence, innovation, and

transformative action in current and future generations of chemical professionals."

https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html (https://www.acs.org/content/acs/en/membership-and-networks/acs/welcoming/diversity.html)

Title IX

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu (mailto:titleix@osu.edu)

Reporting

To report an issue with Title IX or any other form of discrimination (e.g., racial, gender, sexuality, religion), please reach out to me or the department chair Umit Ozkan (ozkan.1@osu.edu (mailto:ozkan.1@osu.edu)). We are committed to an equitable, supportive, and nurturing educational environment.

Counseling and Consultation Service

As a student you may experience a range of issues that can cause barriers to learning, such as strained relationships, increased anxiety, alcohol/drug problems, feeling down, difficulty concentrating and/or lack of motivation. These mental health concerns or stressful events may lead to diminished academic performance or reduce your ability to participate in daily activities. The university offers services to assist you with addressing these and other concerns you may be experiencing. If you or someone you know are suffering from any of the aforementioned conditions, you can learn more about the broad range of confidential mental health services available on campus via the Office of Student Life's Counseling and Consultation Service (CCS) by visiting **ccs.osu.edu** or calling 614-292-5766. CCS is located on the 4th Floor of the Younkin Success Center at 1640 Neil Avenue and also at 1030 Lincoln Tower, 1800 Cannon Drive. You can reach an on call counselor when CCS is closed by calling 614-292-5766. 24-hour emergency help is also available through the 24/7 National Suicide Prevention Hotline at 1-800-273-8255 or at suicidepreventionlifeline.org.

Keep in mind that CCS is not intended to handle every type of problem. They use a triage system that prioritizes students with the most urgent needs. Please check out the mental health resources handout (https://osu.instructure.com/files/27977789/download?download_frd=1) provided in the course files section on Canvas for other options. Also, consider participating in the events organized by the CBE Wellness Committee. Dr. Maxson is the chair of that committee.

Preparation

Last modified: January 13, 2021 by Prof. Maxson

The instructor may make changes to this or any other class document at any time. Always check Canvas for the newest version of any document.

REVISED SYLLABII

CBE 4760: Chemical Engineering Economy and Strategy

Credits: 3 credits (2250 cumulative minutes of lecture)

Instructor: Dr. Andrew Tong

Textbook: Seider, Seader & Lewin, Product & Process Design Principle: Synthesis, Analysis & Evaluation, Wiley & Sons (2009), 3rd Edition.

Description: Economic and strategy considerations in research, development, design, and manufacturing in the chemical process industry.

Pre-requisites: CBE 3610 (610), and enrollment in CBE or EngPhysics major; or Grad standing; or permission of instructor.

Required Course

Course Objectives:

- Master hierarchical design and heuristic approaches to develop and evaluate solutions for process flowsheet determination without extensive computational support
- Master the basic techniques of economic evaluation, including accounting techniques, time value of money concept, taxes, investment, and profit assessment methods that include discounted cash flow, capitalized costs, and return on investment
- Introduce preliminary techniques for using computer-aided process simulation including proficiency with a commercial simulation package, such as ASPEN
- Be familiar with novel product and process design development
- Be familiar with sizing, scale up and costing of various equipment as well as components of an overall plant investment
- Demonstrate proficiency in addressing open-ended design problems based on ambiguous and incomplete data and make suitable/justifiable assumptions
- Be exposed to the basic principles of optimizations strategies and finding an optimum solution

ABET related student learning outcomes	Course Contribution		
	Some	Substantial	Significant
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics			X
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		X	
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		X	
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			X

7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.			X
C. Engineering application of these sciences to the design, analysis, and control of processes, including the hazards associated with these processes			

Topics:

- Product and Process design: Introduction to Plant Design and Development
- Introductory description of Product and Process Development though case study and concept (i.e. Stage-Gate methodology)
- Flowsheet Synthesis and Development: Concepts of stepwise Hierarchical method for Process design, detailed heuristics and rules of thumb for every step, process flow diagrams
- Cost and Asset Accounting: basic accounting relationships, balance sheets and income statements, accounting records, debits and credits, cost accounting methods, basic definitions
- Cost Estimation: general design considerations, cash flow diagrams, cost indexes, scale factors, and components of total capital investment (or total fixed capital cost) calculation
- Time Value of Money Concept: simple and compounding interest, continuous and discrete compounding, present and future worth, annuity, perpetuity and capitalized costs, inflation vs interest, and discounted cash flows
- Annual Expenses and Sales: components and estimation methods of fixed and variable operating costs, annual sales, and forecasting of variable operating unit costs
- Taxes and Depreciation: types of taxes, straight-line, declining balance and modified accelerated cost recovery system (MACRS) depreciation calculation, service and class life, salvage value, and net and gross profit
- Methods of Profit Assessment: return on investment, payback period, discount cash flow analysis
- Equipment Sizing and Estimation: components include compressor, pumps and distillation columns
- Heat Transfer equipment: Fundamentals of heat transfer and heat exchanger designs, introduction to heat exchanger costing and annual expense estimation
- Heat Exchanger Network Design: pinch analysis including composite curve, enthalpy cascade, and grand composite curve, heuristics methods of maximum energy recovery network (MERN) design, and computational analysis methods for MERN design including transshipment linear programming
- Optimum Design and Design Strategy: optimization and objective function, linear programming and dynamic programming, Principle of Optimality, Theory of Reliability and solved examples

CBE 4764: Chemical and Biomolecular Engineering Process Design and Development

Credits: 3 credits (2 lectures per week with separate recitation)

Instructor: Dr. Jeffrey Chalmers, Dr. David Tomasko

Textbook:

Required: Seider, W. D.; Seader, J. D.; Lewin, D. R., Product and Process Design Principles: Synthesis, Analysis & Evaluation, Wiley & Sons (2009), 3rd Edition.

Recommended: Leo Finkelstein Jr., Pocket Book of Technical Writing for Engineers & Scientist, McGraw Hill (1999) 3rd Edition.

Description: Process design studies on selected chemical processes encompassing a broad spectrum of fundamental engineering principles; optimization studies utilizing economic and technical simulation.

Pre-requisites: Prereq or concur: CBE 4760 (760), and enrollment in ChBE major.

Exclusions: Not open to students with credit for 762.

Required Course

Course Objectives:

- Master the principles of process and product design
- Master the use of process simulation software for process analysis
- Integrate material from previous courses to synthesize a complete chemical process plant and design of molecules with desired properties
- Understand and integrate economic considerations in evaluating potential design projects
- Be familiar with the scale and scope of an engineering design project
- Master and apply basic concepts of heat integration
- Be generally familiar with the interaction between design and control
- Appreciate broader societal impacts of chemical processes and products. Learn basic approach of environmental life cycle assessment

Relationship to ABET Criterion 3

ABET related student learning outcomes	Course Contribution		
	Some	Substantial	Significant
8. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	X		
9. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and	X		

welfare, as well as global, cultural, social, environmental, and economic factors			
10. an ability to communicate effectively with a range of audiences	X		
11. 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	X		
12. 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	X		
13. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	X		
14. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	X		
C. Engineering application of these sciences to the design, analysis, and control of processes, including the hazards associated with these processes			

Topics:

- Introduction to chemical engineering process design and overview of the design process. Doulgas's design hierarchy, levels 0, 1 and 2 (input information, input-output structure of the flowsheet)
- Design hierarchy, level 3 (recycle structure)
- Design hierarchy, level 4 (separation system synthesis)
- Heat and power integration
- Heat integrated distillation processes
- Interaction of design and control
- Environmental implications of chemical processes and products
- Introduction; group project, problem statement, and proposed approaches
- Library and internet search of information
- Proposal and creating group web page
- Design experiments and laboratory set up
- Experiment – collecting data and refining experimental procedures
- Experimental data analysis and report

Syllabus updated by Andrew Tong

NEW SYLLABUS
CBE 4755: Chemical Process Safety

Credits: 2 credits (1500 minutes)

Instructor: Dr. Andrew Tong

Textbook: Crowl, Louvar "Chemical Process Safety: Fundamentals with Applications," 4th Edition

(available e-book at OSU Library: https://library.ohio-state.edu/record=b8769106)

Description: Consideration of process safety concepts and application in the chemical process industry.

Pre-requisites: CBE 3421, and enrollment in CBE or EngPhysics major; or Grad standing; or permission of instructor.

Required Course

Course Objectives:

- Become familiar with the process safety issues found in a chemical plant environment
- Become familiar with the range of process safety ethical issues which commingle personal safety and environment protection with enterprise success
- Understand the nature, causes and prevention of major loss events
- Become familiar with process hazard analysis (PHA) methods and tools
- Become familiar with government regulations related to process safety
- Introduce consequence analysis methodology and worst-case estimation assumptions
- Become knowledged in deciphering the anatomy of an incident through PHA and incident case studies
- Understand the importance of process safety management

ABET related student learning outcomes	Course Contribution		
	Some	Substantial	Significant
15. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics		X	
16. 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			X
17. an ability to communicate effectively with a range of audiences			
18. 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	X		
19. 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		X	

20. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	X		
21. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.			X
C. Engineering application of these sciences to the design, analysis, and control of processes, including the hazards associated with these processes	X		

Topics:

- Process Safety Culture: introduction to process safety, code of engineering ethics, pillars of process safety management, tolerable vs acceptable risks, anatomy of an incident
- Chemical Hygiene and toxicology
- Consequence Analysis: source model, hazard material dispersion, flammability and explosions, chemical reactivity, and consequence prevent and mitigation strategies
- Process Hazard Identification and Analysis: introduction to methodologies including checklist, inherent safety review, failure model and effects analysis, what-if hazardous operation (HAZOP) analysis, guided-word HAZOP analysis, management of change, and pre-startup safety review
- Inductive and Deductive Risk Analysis: failure probability concepts, fault tree analysis, event tree analysis, layers of protection analysis and bow-tie concept
- Process safety incident case studies: runaway reactions (e.g. T2), dust explosions (e.g. AL Solutions, Inc.), inherent safety risk, layers of protection/swiss cheese analogy, direct and indirect consequence severity (e.g. Bhopal), safeguard redundancy (e.g. utility such as Fukushima Daiichi), vapor cloud explosion and startup analysis (e.g. BP Texas City), anatomy of an incident and environmental impacts (e.g. Deepwater Horizon)
- Introduction to plant design specifications: components of a front end engineering design package including mechanical design and control specification, piping & instrumentation diagrams (P&ID), pressure vessel and piping standardized mechanical design methodology and certification requirements, determination of maximum allowable working pressure and temperature (MAWP and MAWT)
- Computer-Aided techniques and tools for process hazard and consequence analysis

Subject: Re: Updating Chemical and Biomolecular Engineering Curriculum
Date: Sunday, August 8, 2021 at 11:34:38 PM Eastern Daylight Time
From: Brunelli, Nick
To: Breitenberger, Caroline
CC: Endres, Brian
Attachments: image001.png, image002.jpg

Dear Professor Breitenberger,
I wanted to follow up on my previous email about discussing the proposed curriculum. Specifically, we are planning to make a change in the required courses for Chemical and Biomolecular Engineering (CBE) undergraduate students. Currently, we require that CBE students complete Biology 1113. According to the current required curriculum Bingo sheet, this course is being recommended to be taken by students with senior standing. As such, a majority of our undergraduates (~65%) have opted to test out of the requirement. With these considerations, we have decided to stop requiring undergraduate students to take Biology 1113 as a required course. If this proposed curriculum change is approved, the new curriculum would be implement AU 2022.

Please let me know if you have any questions and/or concerns. Take care.

Sincerely,
Nick

From: Brunelli, Nick <brunelli.2@osu.edu>
Date: Monday, August 2, 2021 at 11:33 PM
To: Breitenberger, Caroline <breitenberger.1@osu.edu>
Subject: Updating Chemical and Biomolecular Engineering Curriculum

Dear Professor Breitenberger,
I hope that you are doing well.

I am reaching out to you since I am chairing a working group in the Chemical and Biomolecular Engineering (CBE) department. David Tomasko provided your name to me as the contact for a few courses. Specifically, the courses would include: Biology 1113; Molecular Genetics 4500.01; and Biochemistry 4511.

Would you be the appropriate contact to discuss these courses?

For a little more context, we in the CBE department have formed a Curriculum Working Group (CWG) to examine all aspects of the curriculum. The primary purpose of the CWG is to examine discuss the aspects of the curriculum that has worked and hasn't worked since we have converted from quarters to semesters. A secondary purpose is to examine ways to make the curriculum more flexible and beneficial for students. We are examining all aspects and wanted to discuss these courses with you.

Take care.

Please let me know if you have any questions and/or concerns.

Sincerely,
Nicholas A. Brunelli

THE OHIO STATE UNIVERSITY

Nicholas A. Brunelli, PhD
THE Associate Professor
THE H.C. "Slip" Slider Professorship
THE Graduate Studies Chair
THE Ohio State University
William G. Lowrie Department of Chemical and Biomolecular Engineering
253 CBEC (Chemical and Biomolecular Engineering and Chemistry) Building, 151 W. Woodruff Ave, Columbus, OH 43210
614-688-3400 Office
brunelli.2@osu.edu / catalysts.osu.edu
Pronouns: he/him/his / Honorific: Prof.

TIME AND CHANGE
THE OHIO STATE CAMPAIGN

Buckeyes consider the environment before printing.

Subject: Re: Updating Chemical and Biomolecular Engineering Curriculum
Date: Sunday, August 8, 2021 at 11:44:04 PM Eastern Daylight Time
From: Brunelli, Nick
To: Gramila, Thomas
CC: Endres, Brian
Attachments: image001.png, image002.jpg

Dear Professor Gramila,
I wanted to follow up on my previous email about the proposed modifications to the Chemical and Biomolecular Engineering (CBE) curriculum. Over this past eight months, the CBE department has discussed the undergraduate curriculum. Our current requirements for graduation included 132 credit hours, which constrains our undergraduate students' ability to schedule courses. As we move forward, we have proposed a new curriculum that would reduce the total number of credit hours to 125. In identifying the core elements for the curriculum, we have decided to stop requiring CBE students to take Physics 1251 as a graduation requirement. We plan to submit these changes for approval. If approved, the changes would be implemented at earliest for the AU 2022 semester.

Please let me know if you have questions and/or concerns. Take care.

Sincerely,
Nick

From: Brunelli, Nick <brunelli.2@osu.edu>
Date: Monday, August 2, 2021 at 11:37 PM
To: Humanic, Thomas <humanic.1@osu.edu>, Gramila, Thomas <gramila.1@osu.edu>
Subject: Updating Chemical and Biomolecular Engineering Curriculum

Dear Professors Humanic and Gramila,
I hope that you are doing well.

I am reaching out to you since I am chairing a working group in the Chemical and Biomolecular Engineering (CBE) department. David Tomasko provided your names to me as the contact for courses in Physics.

Would you be the appropriate contact to discuss these courses?

For a little more context, we in the CBE department have formed a Curriculum Working Group (CWG) to examine all aspects of the curriculum. The primary purpose of the CWG is to examine discuss the aspects of the curriculum that has worked and hasn't worked since we have converted from quarters to semesters. A secondary purpose is to examine ways to make the curriculum more flexible and beneficial for students. We are examining all aspects and wanted to discuss these courses with you.

Take care.

Please let me know if you have any questions and/or concerns.

Sincerely,
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Pronouns: he/him/his / Honorific: Prof.

Buckeyes consider the environment before printing.

Subject: Re: Updating Chemical and Biomolecular Engineering Curriculum
Date: Sunday, August 8, 2021 at 11:29:09 PM Eastern Daylight Time
From: Brunelli, Nick
To: Husen, William
CC: Endres, Brian
Attachments: image001.png, image002.jpg

Dear Bill,
Thank you for the discussion of the curriculum. I look forward to working with you on the points that we discussed. This email is to confirm the points that we discussed in our meeting on Thursday.

As we discussed, the proposed changes to the Chemical Engineering curriculum will have potential impact on enrollment in Math and/or Statistics courses. We are modifying our technical elective requirements to include an additional technical elective. Specifically, we are now allowing CBE 5779 to satisfy the Math/Stats technical elective requirement for our undergraduate students. CBE 5779 has been a popular technical elective (~85% of our undergraduates take the course). Also, we will be requiring students to take the Math series 1151, 1172, and 2173 as the overall calculus and differential equation sequence. As we transition from the current curriculum to the new curriculum, we have created a transition plan. Students that have already completed the required courses will not be required to take the new proposed requirement. If approved, we anticipate that these changes would be implemented at earliest in the Fall 2022.

Please let me know if you have additional questions.

Sincerely,
Nick

From: Husen, William <husen@math.ohio-state.edu>
Date: Wednesday, August 4, 2021 at 3:02 PM
To: Brunelli, Nick <brunelli.2@osu.edu>
Cc: Endres, Brian <endres.10@osu.edu>
Subject: Re: Updating Chemical and Biomolecular Engineering Curriculum

Dear Nick,

1pm tomorrow (8/5) should work for me.

All the best,
Bill

From: Brunelli, Nick <brunelli.2@osu.edu>
Sent: Tuesday, August 3, 2021 10:07 PM
To: Husen, William <husen@math.ohio-state.edu>
Cc: Endres, Brian <endres.10@osu.edu>
Subject: Re: Updating Chemical and Biomolecular Engineering Curriculum

Dear Bill,
Thanks for the email.

Currently, there is a range of courses that CBE students are required to take. Specifically, we require students to take a Math (typically Linear Algebra) or Stats technical elective. There are a variety of courses that students take to fulfill this requirement. Also, we require students take the engineering math sequence: Math 1151, 1172, and 2177.

If you had 30 minutes on Thursday or Friday, we could schedule some time to discuss. I would suggest 1:00 pm on Thursday (8/5) if that works for you.

I am also available:
Wednesday (8/4) – 9:30 – 11 am OR 12 – 1 pm OR 2 – 2:30 pm OR 3:30 – 4:30 pm
Thursday (8/5) – 9:30 – 11:30 am OR 12:30 – 3 pm
Friday (8/6) – 9:30 – 10 am OR 1:30 – 4:30 pm

Sincerely,
Nick

From: Husen, William <husen@math.ohio-state.edu>
Date: Tuesday, August 3, 2021 at 10:48 AM
To: Brunelli, Nick <brunelli.2@osu.edu>
Subject: Re: Updating Chemical and Biomolecular Engineering Curriculum

Dear Nick,

Thanks for contacting me about this. I would imagine I would be the person to start any discussions concerning our math courses. Could you let me know what courses are under review and any other details?

All the best,
Bill

William J. Husen, Ph.D.
Director of Undergraduate Instruction
Department of Mathematics
The Ohio State University

From: Brunelli, Nick <brunelli.2@osu.edu>
Sent: Monday, August 2, 2021 11:38 PM
To: Husen, William <husen@math.ohio-state.edu>
Subject: Updating Chemical and Biomolecular Engineering Curriculum

Dear Professor Husen,
I hope that you are doing well.

I am reaching out to you since I am chairing a working group in the Chemical and Biomolecular Engineering (CBE) department. David Tomasko provided your name to me as the contact for a few Math courses.

Would you be the appropriate contact to discuss these courses?

For a little more context, we in the CBE department have formed a Curriculum Working Group (CWG) to examine all aspects of the curriculum. The primary purpose of the CWG is to examine discuss the aspects of the curriculum that has worked and hasn't worked since we have converted from quarters to semesters. A secondary purpose is to examine ways to make the curriculum more flexible and beneficial for students. We are examining all aspects and wanted to discuss these courses with you.

Take care.

Please let me know if you have any questions and/or concerns.

Sincerely,
Nicholas A. Brunelli

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