

Chemical and Biomolecular Engineering / CBE4000
Introduction to Product and Process Design
Fall Semester / F24

-- COURSE STAFF --

INSTRUCTOR

Dr. Sean Holleran (he/him)
354 Towne Building
seanholl@seas.upenn.edu
OH: Thursdays [noon – 1:00pm]

CBE4590

Bruce Vrana (he/him)
312 Towne Building
vrana@seas.upenn.edu
OH: (by appointment)

TEACHING ASSISTANT

Shrey Kalpeshkumar Patel (he/him)
shreykp@seas.upenn.edu
OH: Tuesdays [5:00pm – 6:00pm]

-- COURSE LECTURE TIMES/LOCATIONS --

Mondays	10:15am – 11:15am	311 Towne
Wednesdays	10:15am – 11:15am	311 Towne
Fridays	10:15am – 11:15am	303 Towne

Monday(PM)	5:15pm – 6:45pm	313 Towne (327 Towne)

-- COURSE CANVAS / TEXTBOOK / RESOURCES --

CANVAS SITE

<https://canvas.upenn.edu/courses/1811344>

TEXTBOOK

Seider, W.D., D.R. Lewin, J.D. Seader, S. Widagdo, R. Gani, and K.M. Ng,
Product and Process Design Principles: Synthesis, Analysis, and Evaluation,
Fourth Edition, Wiley, 2017.

MULTIMEDIA

Seider, W.D., D.R. Lewin, J.D. Seader, C. Novak, and A. Kishun,
Using Process Simulators in Chemical Engineering,
available free through Penn CETS ...
<https://www.seas.upenn.edu/~cbe400/aspen/>

-- COURSE LEARNING OBJECTIVES --

After completing this course, students will ...

1. be able to carry out process synthesis using heuristics and process simulation methods.
2. have evaluated several process simulations using ASPEN PLUS.
3. have learned to synthesize distillation trains for nearly-ideal mixtures, and have been introduced to the synthesis of distillation trains for azeotropic mixtures.
4. be able to perform a second-law analysis; that is, calculate the lost work and thermodynamic efficiency for a chemical process.
5. be able to incorporate heat integration of process flowsheets.
6. be able to design a heat exchanger.
7. be able to size and estimate the costs for distillation complexes, heat exchangers, pumps, compressors, expanders, and other kinds of equipment, using many cost equations.
8. be able to carry out a profitability analysis for a chemical process design.
9. for students not participating in an interdisciplinary senior design (ISD) project, have been assigned a CBE4590 product/process design project, and through solution of many homework exercises, be prepared to undergo the design effectively.

-- COURSE OUTLINE --

Process Creation / Preliminary Process Synthesis	(Ch 2)
Heuristics for Process Synthesis	(Ch 6)
Process Simulation / ASPEN PLUS	(Ch 7)
Synthesis of Separation Trains, Azeotropic Distillation	(Ch 9)
Second Law Analysis / Thermo Efficiency, Lost Work Analysis	(Ch 10)
Synthesis of Heat Exchanger Networks	(Ch 11)
Detailed Equipment Design (including HX Design)	(Ch 12 + Ch 13)
Capital Cost Estimation	(Ch 17)
Profitability Analysis and Time Value of Money	(Ch 17)
<i>Selection of Design Projects for CBE4590 and begin work on Design Projects for CBE4590</i>	

-- GRADING STRUCTURE --

Homework - - - - -	10%
Midterm Exam - - - - -	30%
Meetings with Design Team (advisor, consultant, teammates) [2x] - - - -	5%
Fall Design Presentation - - - - -	15%
Final Exam - - - - -	40%
TOTAL	100%

-- HOMEWORK POLICY --

Homework problem sets (10% of your total course grade) will be assigned to align with content from the course lectures. These will (generally) be due on Wednesdays (10:15am ... before the class lecture time) – and I will try to ensure that a problem set is posted at least one week in advance of its due date. Homework will be submitted (digitally) via Canvas. Homework solutions will be made available (also via Canvas) after the submission deadline.

I am working to reduce the total number of homework assignments associated with CBE4000.

All students may have up to two (2) “excused HW skips” to use at any time throughout the semester. All students are still fully responsible for content related to all homework assignments and remain personally responsible for exam preparedness.

If you are a student who completes all of the homework assignments – then I will retain your best [$n - 2$] scores when determining your homework average for the course grading calculation.

-- MIDTERM EXAM SCHEDULE --

CBE4000 Midterm Exam
Monday October 28
5:15pm – 6:45pm (80 minutes)

-- FULL SCHEDULE FOR MONDAY(PM) SESSIONS --

I am, on purpose, trying to be more forward about when (why) we will need to use the Monday(PM) recitation times. I am providing you here the schedule for Monday evenings – so that you can plan your fall semester activities accordingly. Students are expected to be present for the Monday sessions shown here:

*Mon Sep 02 *open* (Labor Day)*

Mon Sep 09 YES [Bruce Vrana visit to discuss CBE4590 / introduce design project statements]

*Mon Sep 16 *open**

*Mon Sep 23 *open**

Mon Sep 30 YES [Bruce Vrana reveals CBE4590 team / project / advisor assignments]

*Mon Oct 07 *open**

Mon Oct 14 YES [Doug McGee and Judith Currano ... library resources for CBE4590 projects]

Mon Oct 21 YES [CBE4590 team work session] / **SPECIAL LOCATION = 327 TOWNE**

Mon Oct 28 YES [CBE4000 Midterm Exam]

Mon Nov 04 YES [CBE4590 team work session] / **SPECIAL LOCATION = 327 TOWNE**

*Mon Nov 11 *open**

Mon Nov 18 YES [Fall Presentations – A]

Mon Nov 25 YES [Fall Presentations – B]

*Mon Dec 02 *open* (Monday following Thanksgiving Break)*

*Mon Dec 09 *open* (last day of the F24 semester)*

This schedule uses eight of the fifteen Mondays during the term (there are seven unused Monday evenings) ... and seven of those eight instances are directly associated with incorporating more CBE4590 in the fall semester.

-- IMPORTANT NOTES RELATED TO DESIGN PROJECTS --

Bruce Vrana will be the primary lecturer for some topics that are particularly important for the CBE4590 design projects (Capital Cost Estimation, Time Value of Money, and Profitability Analysis). He will present to the class (during the regular M/W/F 10:15am lecture time) for the final eight lecture hours.

We are using two of the Monday(PM) sessions directly for allotted time when student teams will work together (guaranteed availability) in the initial stages of their project design. Each design team will have its own table for independent group efforts. Dr. Holleran and Prof. Vrana will be present during the Monday(PM) work sessions to interact with the design teams.

Student teams are required to meet with their full project staff (all team members, faculty advisor, industrial consultant author, Bruce Vrana) for two one-hour meetings during the fall semester. ZOOM meetings are acceptable for this requirement. Student teams are responsible for scheduling/arranging these fall semester meetings. CBE faculty advisors are aware that student teams will need their attention for meetings during the fall semester.

- First meeting must occur between **Tuesday October 22** and **Sunday November 3**.
- Second meeting must occur between **Tuesday November 5** and **Friday November 15**.

Bruce Vrana must be invited to participate in all meetings. Within one week of announcing teams (i.e., by October 7), teams should reach out to all participants to schedule these meetings. When2meet.com or similar sites have proven helpful in the past, as everyone has busy schedules.

We are aware that some CBE4590 projects are authored by Penn students (and do not have an industrial consultant initially associated with the project). Bruce Vrana is working to identify industrial consultants to serve as “proxy consul” for any/all student authored projects. All student design teams will have an industrial consultant to work with during the fall semester – either as the original project author or as assigned to student authored projects.

All student teams will offer a (graded) fall presentation of their initial design progress. Each team will prepare a 20-minute presentation for one of the two Monday(PM) sessions (schedule later in the semester). I will provide details about the expectations associated with the presentations in mid-October. Expectations will include some preliminary quantitative results (first-order material balance, economic potential of the project, rough energy balances, etc.).

-- OTHER NOTEWORTHY DATES DURING F24 --

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| Mon Sep 02 | = no class (Labor Day) |
| Sun Sep 15 | = Senior Picnic [11:30am – 3:00pm / Dr. Seider’s home] |
| Fri Oct 04 | = no class (Fall Break) |
| Wed Nov 27 | = no class (day before Thanksgiving) |
| Fri Nov 29 | = no class (Thanksgiving Break) |