CBE 3323B - Staged Operations
Course Outline 2025-2026

Description

This course will focus on the staged unit operations in chemical engineering. It is designed to familiarize the students with the nature and theory of chemical engineering unit operations, and physical separation processes based on the ideal (equilibrium) stage concept.

Prerequisite(s): CBE 2220A/B, CBE 2221A/B, CBE 2224A/B.
Corequisite(s): CBE 3395Y or CBE 3396Y or registration in the Artificial Intelligence Systems Engineering program.

Unless you have either the requisites for this course or written special permission from your Dean to enrol in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to have the necessary prerequisites.

Contact Hours
3 lecture hours, 1 tutorial hour, 0.5 course.

Instructor
Dr. Andrew Hrymak. Email: ahrymak@uwo.ca

Undergraduate Assistant
(TEB 477) Telephone: 519-661-2111 ext: 82131 email: cbeundergraduate@uwo.ca

Recommended Text
Lecture notes will be provided at the course OWL site. Example problems will have abbreviated solutions.

Course Notes
OWL Brightspace course website will be used for all lecture notes, assignments, resource materials.

Reference Texts
*Coulson and Richardson's Chemical Engineering, Volume 2B: Separation Processes, 6th Edition, Edited by Ajay K Ray, Butterworth-Heinemann, 2023.**
*Principles of Mass Transfer and Separation Process, Binay K. Dutta, PHI Learning, 2009.**
Separation Process Principles, Seader and Henley, 2nd Edition, John Wiley $ Sons, 2006.
Unit Operations in Chemical Engineering, McCabe, Smith and Harriott, 7th edition, McGraw Hill, 2005.
Transport Processes and Separation Process Principles (Includes Unit Operations), C.J. Geankoplis, 4th edition, Prentice Hall PTR, 2003.
(*) Course notes based on these two references including some figures.

Units

SI predominantly and other engineering units.

General Learning Objectives

1. Understanding thermodynamics of various separation processes
2. Learning how to apply graphical and analytical methods and mass balance to perform calculations
3. Performing calculation for flash and differential distillation
4. Understanding the principles of materials and enthalpy balance in a distillation column
5. Understanding the main design parameters in distillation columns and learn procedure for designing a distillation column.
6. Understanding the principles of material balance in adsorption, absorption and liquid-liquid extraction systems

Accreditation (AU) (CEAB):

Engineering Science = 50%
Engineering Design = 50%

Graduate Attributes (CEAB):

Knowledge Base	D	Use of Engineering Tools		Impact on Society and the Environment	
Problem Analysis		Individual and Teamwork		Ethics and Equity	
Investigation		Communication Skills		Economics and Project Management	
Design	D	Professionalism		Life-Long Learning	

D: Developed

KB3: Demonstrate competence in engineering fundamentals: learning objectives 1 and 3

KB4: Demonstrate competence in specialized engineering knowledge: learning objectives 1 and 3

DE3: Demonstrate ability to select candidate engineering design solutions for further development: learning objective 5

DE4: Demonstrate ability to advance an engineering design to a defined end state – completion: learning objective 5

Specific Learning Objectives

Thermodynamics of Separation Processes

- understand the concepts of thermodynamics and its application in staged operations.
- understand equilibrium diagrams for ideal and non-ideal systems.
- understand non-ideal thermodynamic property models and their application in separation processes.
- apply graphical and analytical methods and mass balance to perform calculations.

Single Stage Operations - Differential and Flash Distillation

- understand the concept of differential distillation.
- perform calculation for differential distillation for two-component systems.
- understand the concept of flash distillation.
- perform calculation for flash distillation for multi-component systems.
- use enthalpy-concentration diagrams.

Continuous Distillation

- understand the concepts of continuous distillation.
- understand the principles of materials and enthalpy balance in a distillation column.
- use McCabe-Thiele method for distillation column calculations.
- understand such key concepts as reflux ratio, minimum and total reflux, number of theoretical stages, plate efficiency, feed conditions, optimal feeding plate, feeding at plate other than the optimal feeding plate.
- understand the principles and perform calculations for distillation with multiple feed streams and side streams.
- compare packed towers and plate columns performances in continuous distillation processes.
- understand the main design parameters in distillation columns.

Gas Absorption and Stripping

- understand the concepts of gas absorption and stripping,
- understand the principles of materials balance,
- perform essential calculations for single stage and multi-stage absorption process and
- understand the key design parameters in adsorption process.

Adsorption

- understand the concepts of adsorption,
- understand the principles of materials balance,
- perform essential calculations for single stage and multi-stage adsorption process and
- understand the key design parameters in adsorption process.

Liquid-liquid Extraction

- understand the concepts of liquid-liquid extraction,
- understand the principles of materials balance,
- perform essential calculations for single stage, multi-stage cross-current and multi-stage counter-current extractions and
- understand the key design parameters in Liquid-liquid extraction.

Evaluation

The final course mark will be determined as follows:

Assignments	4% (4 assignments, approximately biweekly)
Quizzes	16% (4 quizzes, based on assignments)
Mini-project (simulation and design)	10%
Mid-term Examination	30% (February 23, 2025; 4:30 pm – 6:30 pm)
Final Examination	40%
Total	100%

Notes

1) Mid-term exam (2 hours) and final exam (3 hours) will be closed book tests. No aids allowed except non-communicating calculator. Notes, textbooks and other reference materials will not be allowed. Equations will be provided by the instructor for the midterm and final examination.
2) In-class quizzes will be 40 minutes, no aids allowed except non-communicating calculators.
3) Assignment solutions will be provided in advance of each quiz.
4) No make-up mid-term or quizzes will be re-scheduled. However, students who miss the mid-term exam or in-class quizzes, if provided a justified reason (submission of self-reported absence academic consideration in advance), may be allowed to shift the mid-term exam/quiz weight to the final exam.

Repeating All Components of the Course

In accordance with Senate and Faculty Policy, students who have failed an Engineering course (i.e. <50%) must repeat all components of the course. No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years

Use of English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

Attendance

Attendance in lectures and tutorials is mandatory. Any student who, in the opinion of the instructor, is absent too frequently from class periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

Cheating

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar).

Statement on Academic Offenses

Students must write their team reports in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).
The University of Western Ontario has software for plagiarism checking. Students may be required to submit their work in electronic form for plagiarism checking.

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following website: https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_offences.pdf.

All required reports may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All report submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between Western University and Turnitin.com (http://www.turnitin.com).

Conduct

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

Sickness and Other Problems

Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented. The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

Notices

Students are responsible for regularly checking their Western email.

Consultation

Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

Statement on Use of Electronic Devices

Non-communicating electronic calculators will be allowed during tests and examinations.

Statement on the Use of Generative Artificial Intelligence (AI)

The use of generative artificial intelligence (AI) tools/software/apps is unacceptable in the course.

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All assignments may be subject to submission for textual similarity review to the commercial plagiarism

detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (http://www.turnitin.com).

Support Services

Registrarial Services: http://www.registrar.uwo.ca)
Student Support Services: http://westernusc.ca/services/

Gender-Based and Sexual Violence

Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who is going through or has gone through these traumatic events. If you are experiencing or have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at the following website:
https://www.uwo.ca/health/student_support/survivor_support/gethelp.html
To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Students who are in emotional/mental distress should refer to Mental Health@Western http://www.uwo.ca/uwocom/mentalhealth/ for a complete list of options about how to obtain help.

Nov 25, 2022
Rev Dec 5, 2024, Dec 31 2024, Nov 25 2025.