EQ022 – Topics in Separation Processes

First semester of 2026, Class A
Wednesdays, 7:00–11:00 p.m.
Room: SIFEQ-1 (yellow walls)

Course description: Study of selected topics in separation processes.
Total course load: **60 hours (4 credits)**
Language of instruction: **English**

Instructor

Prof. Jean Felipe Leal Silva
Email: jeanf@unicamp.br
Office E-207 (DEPro, Building E)

Learning objective

To learn methodologies for simulating and analyzing the following separation processes: azeotropic distillation, cryogenic distillation, distillation with heat pumps, membrane separation, physical absorption, reactive absorption, and deep eutectic solvents.

Course content

1. ***Overview of separation processes (4 hours)***
2. ***Enhanced distillation (20 hours)***
   - 2.1. Shortcut and rigorous modeling
   - 2.2. Azeotropic distillation
   - 2.3. Cryogenic distillation
   - 2.4. Heat pumps in distillation
3. ***Biogas upgrading (16 hours)***
   - 3.1. Physical absorption of CO_2
   - 3.2. Reactive absorption of CO_2
   - 3.3. Removal of other contaminants
4. ***Membranes (8 hours)***
   - 4.1. Fundamentals and applications
5. ***Deep eutectic solvents (12 hours)***
   - 5.1. Fundamentals and applications
   - 5.2. Parametric studies

Teaching methodology

The course will consist of brief lectures covering the concepts needed to understand the topics addressed in separation processes, together with discussions of case studies illustrating applications of these technologies. The main emphasis of the course will be on hands-on work, allowing students to learn the methodologies underlying the design and

evaluation of these technologies. Following the lectures, students will be given a problem to solve using process simulation software (problem-based learning). The resulting simulation model will serve as the basis for technical reports, in which students must demonstrate their ability to use the model to simulate different scenarios and as an analytical tool for assessing key separation-process criteria.

Assessment activities

Course assessment will be based on five technical reports:

- Report 1: Azeotropic and cryogenic distillation (r_1)
- Report 2: Heat pumps in distillation (r_2)
- Report 3: Biogas upgrading (r_3)
- Report 4: Membranes versus absorption (r_4)
- Report 5: Solvent comparison (r_5)

Final grade calculation

At the end of the academic term, each student's partial average (MF) will be calculated:

$$MF = 0.2 \times r_1 + 0.2 \times r_2 + 0.3 \times r_3 + 0.1 \times r_4 + 0.2 \times r_5$$

If $MP \geq 7.0$, the student is exempt from the final examination, and the final grade (MF) is equal to MP:

$$MF = MP, \quad if\ MP \geq 7.0$$

If $2.5 \leq MP < 7.0$, the student may take the final examination ($Exam$), which will be a regular test. In this case, the final grade (MF) will be calculated from the partial grade (MP) and the examination grade, with the result capped at 7.0:

$$MF = \begin{cases} (0.4 \times Exam + 0.6 \times MP), & if\ (0.4 \times Exam + 0.6 \times MP < 7.0) \\ 7.0 & , \quad if\ (0.4 \times Exam + 0.6 \times MP \geq 7.0) \end{cases} \quad if\ MP < 7.0$$

If $MP < 2.5$, the student fails the course and is not eligible to take the final examination.

→ Bonus points may be awarded during classes throughout the semester!

Passing Requirements

- $\boldsymbol{MF \geq 5.0, MP \geq 2.5}$ **and a**ttendance of at least 75%
- Excused absences: Article 72 of the UNICAMP General Undergraduate Regulations.

Excused absences

Absences may be excused in the circumstances specified in Article 72 of the University's General Undergraduate Regulations (reproduced in the box below). Please note that

medical certificates and requests for excused absences under Article 72 must be submitted exclusively through the e-DAC system and must not be sent directly to the course instructor. For further guidance, please contact the Undergraduate Studies Office.

Art. 72. Absences may be excused in the cases described below, provided that supporting documentation is submitted to the Academic Directorate within 15 (fifteen) days of the occurrence, during the academic term.

I – Service as a student representative on collegiate bodies, during meeting hours;

II – Summons to fulfill legally mandated duties;

III – Death of a spouse, child (including a stillborn child), parent, sibling, or grandparent: up to 3 (three) days;

IV – Death of a stepparent, parent-in-law, or sibling-in-law: up to 2 (two) days.

V – Participation as a student representative in competitions, conferences, interdisciplinary extracurricular activities, or other institutional curricular activities, subject to the following criteria:

a) Requests for leave must be submitted to the student's program coordinator at least 15 days in advance;

b) The maximum period of excused absence is 5 days for regional or national competitions or conferences and 10 days for international competitions or conferences.

c) The maximum period of excused absence is 5 days for national or regional competitions and 10 days for international competitions;

d) At the instructor's discretion, provided that this is specified in the Course Development Plan, the final examination may replace an assessment held on the day of the excused absence.

VI – Paternity leave, for a maximum of 5 (five) consecutive days, may be requested upon presentation of a birth certificate. This provision also extends to adoption and the granting of legal custody for adoption purposes, upon presentation of a birth certificate.

Sole paragraph. An excused absence does not entitle the student to make-up instruction from the instructor responsible for the course.

Right to a make-up assessment

Students may take a make-up assessment in the circumstances provided for in Articles 78-A and 78-B of the General Undergraduate Regulations (reproduced in the box below). In such cases, the make-up assessment will be the Final Examination (see the date in the next section).

Art. 78-A. Students who are duly enrolled are guaranteed, in the exercise of freedom of conscience and religion, the right to be absent from an examination or class scheduled on a day when such activities are prohibited by the tenets of their religion, subject to a prior, reasoned request and in accordance with applicable legislation.

Art. 78-B. Students who are absent from a class on a day when a test or examination is held are entitled to a make-up assessment, provided that supporting documentation is submitted to the Academic Directorate within 15 (fifteen) days. The assessment must be scheduled directly with the instructor responsible for the course in the following cases:

I – An excused absence as provided for in Article 72;

II – Mandatory fieldwork or academic activities, supported by a document signed by the coordinator of the student's program;

III – Submission of a medical certificate;

§1 – The final examination or another assessment activity may replace the assessment(s) held on the day(s) of the student's absence, provided that this arrangement is specified in the Course Development Plan.

§2 – When an absence is excused under item V of Article 72, the student is limited to 1 (one) make-up assessment per course per semester.

Course Schedule

Date	Class	Topic	Deliverable
24/02/2027	1	Introduction and fundamentals	
03/03/2027	2	Shortcut and equilibrium distillation	
10/03/2027	3	Rate-based distillation	
17/03/2027	4	Azeotropic distillation	
24/03/2027	5	Cryogenic distillation	Report 1
31/03/2027	6	Heat pumps in distillation	
07/04/2027	7	Heat pumps in distillation	Report 2
14/04/2027	8	Physical absorption	
21/04/2027		Holiday - Tiradentes	
28/04/2027	9	Reactive absorption	
05/05/2027	10	Comparison of routes	Report 3
12/05/2027	11	H2S removal	
19/05/2027	12	Membranes	
26/05/2027	13	Membranes	Report 4
02/06/2027	14	Deep eutectic solvents	
09/06/2027		ESCAPE 37	
16/06/2027		IFFW 2027	
23/06/2027	15	Deep eutectic solvents	Report 5

Recommended references

- Al-Malah, K.I.M., Aspen Plus: Chemical Engineering Applications. Wiley, 2017.
- Sandler, S.I., Using Aspen Plus in Thermodynamics Instruction: A Step-by-Step Guide. Wiley, 2015.
- Towler, G., and Sinnott, R., Chemical Engineering Design, 2nd edition, 2012.
- Seader, J.D., and Henley, E.J., Separation Process Principles, 2nd edition, Wiley, 2005.