



### TEACHING PLAN – 2022-3

COURSE IDENTIFICATION			
CODE	NAME	PERIOD	TOTAL TIME
EAL10019	Processos com membranas	13:30 – 17:30 Wednesday	45 h

PROFESSORS	CONTACT
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GRADUATE PROGRAM COURSE
Pós-Graduação em Engenharia de Alimentos

COURSE SYLLABUS
Fundamentals of membrane separation processes. Applications of membranes processes. Membrane preparation materials and techniques. Characterization techniques. Classical and emerging processes using membranes. Transport, concentration polarization, and fouling phenomena in membrane processes. Integrated membrane processes.

OBJECTIVES
Understand the fundamentals of membrane processes. Understand the techniques for the preparation/manufacturing of membranes. Know the membrane characterization techniques and the main parameters to be evaluated. Know the main techniques that use membranes and emerging processes. Distinguish the appropriate membrane technique for a given application. Understand the transport across membranes and the effects of concentration polarization and fouling.

COURSE PROGRAM
<i>Topic 0 – Introduction to the course</i>
<i>Topic 1 – Introduction to membrane processes</i> Membrane and membrane processes, main applications, scientific journals.
<i>Topic 2 – Basic concepts</i> Classification, main characteristics, membrane modules, terminology, flow configuration, operating configuration, operating modes, and operating parameters.
<i>Topic 3 – Membrane preparation</i> Polymeric membrane preparation. Inorganic membrane preparation.
<i>Topic 4 – Membrane characterization</i> Membrane performance, selectivity morphology, pore size and pore size distribution, mechanical, chemical, and thermal resistance, hydrophilic/hydrophobic character, crystallinity, glass transition temperature.



*Topic 5 – Transport characteristics*

Transport fundamentals of MF, UF, RO, PV, and PG.

Phenomena associated to the membrane processes: compaction, concentration polarization, film theory, cake theory, fouling.

*Topic 6 – Emerging Processes and Integrated Systems*

Emerging membrane processes such as FO, PRO, RED, etc., and integrated systems.

**SCHEDULE**

<b>Week 1</b>	
Pre-class	
In-class (21-Sep)	Topic 0 – Introduction to the course Topic 1 – Introduction to membrane processes <a href="#">Activity 1.1 – Membrane + Scientific journals + collaborative text (1,0)</a>
Post-class	
<b>Week 2</b>	
Pre-class	<a href="#">Activity 2.1 – Basic concepts</a>
In-class (28-Sep)	Topic 2 – Basic concepts <a href="#">Activity 2.1 – Discussion + collaborative text Part 1</a>
Post-class	
<b>Week 3</b>	
Pre-class	
In-class (5-Oct)	Topic 2 – Basic concepts <a href="#">Activity 2.1 – Discussion + collaborative text Part 2 (1,5)</a>
Post-class	
<b>Week 4</b>	
Pre-class	
In-class (12-Oct)	Holiday
Post-class	
<b>Week 5</b>	
Pre-class	<a href="#">Activity 3.1 – Videos + Quiz</a>
In-class (19-Oct)	Topic 3 – Membrane preparation <a href="#">Activity 3.1 – Discussion Part 1</a>
Post-class	
<b>Week 6</b>	
Pre-class	<a href="#">Activity 3.1 – Videos + Quiz</a>
In-class (26-Oct)	Topic 3 – Membrane preparation <a href="#">Activity 3.1 – Discussion Part 2 (1,0)</a>
Post-class	

<b>Week 7</b>	
Pre-class	
In-class (2-Nov)	Holiday
Post-class	
<b>Week 8</b>	
Pre-class	<a href="#">Activity 4.1 – Poster section Part 1</a>
In-class 9-Nov	Topic 4 – Membrane characterization <a href="#">Activity 4.1 – Poster section Part 2</a>
Post-class	
<b>Week 9</b>	
Pre-class	
In-class (16-Nov)	Topic 4 – Membrane characterization <a href="#">Activity 4.1 – Poster section Part 3 (2,5)</a>
Post-class	
<b>Week 10</b>	
Pre-class	
In-class (23-Nov)	Topic 5 – Transport characteristics
Post-class	<a href="#">Activity 5.1 – Presentation Part 1</a>
<b>Week 11</b>	
Pre-class	
In-class (30-Nov)	Topic 5 – Transport characteristics <a href="#">Activity 5.1 – Presentation Part 2 (2,0)</a>
Post-class	
<b>Week 12</b>	
Pre-class	
In-class (7-Dez)	Topic 6 – Emerging Processes and Integrated Systems <a href="#">Activity 6.1 – Searching, reading and presentation (2,0)</a> Course evaluation
Post-class	

#### TEACHING METHODOLOGY / PROGRAM DEVELOPMENT

- a) Communication: communication with students will be through the Moodle virtual learning environment and by email.
- b) Classroom lectures: slide presentation and materials. In addition, solving of exercises, discussion of cases and presentation of seminars will take place simultaneously. The seminars will be used as a form of creative learning and in-depth reflection on the covered topics.



### STUDENT LEARNING ASSESSMENT

Student learning will be assessed throughout the semester from the various activities proposed. The assessment will be based on the quality of the content presented. The final grade (NF) will be calculated as follows:

**NF = sum of points of each activity presented in the schedule.**

Student performance (according to PPGEAL Internal Resolution/2022)

If  $NF \geq 7.0$  the student is approved

If  $3.0 < NF < 7.0$ , the student can do a recovery exam (Rec)

If  $NF < 3.0$  the student is not approved

The Rec will be composed of all the topics studied on the course.

If  $(NF + Rec)/2 \geq 7.0$  the student is approved

If  $(NF + Rec)/2 < 7.0$  the student is not approved

A minimum attendance of seventy-five percent ( $\geq 75\%$ ) is required for approval.

### BASIC REFERENCES

Habert AC, Borges CP, Nobrega R. Processos de Separação por Membranas. UFRJ editor. Esc. Pilot. em Eng. Química. Rio de Janeiro: e-papers; 2006.

Baker RW. Membrane technology and applications. 3rd ed. Chichester, England: John Wiley&Sons, Ltd; 2012.

Mulder M. Basic Principles of Membrane Technology. Dordrecht, The Netherlands: Kluwer Academic Publishers; 1996.

Weblinks available via Moodle or in the course's Google Drive.

### COMPLEMENTARY REFERENCES

Gitis V, Rothenberg G. Ceramic Membranes: New Opportunities and Practical Applications. Weinheim: Wiley-VCH; 2016.

Li K. Ceramic Membranes for Separation and Reaction. 1st ed. Chem. Eng. Chichester, England: John Wiley & Sons, Ltd.; 2007.

Porter MC. Handbook of industrial membrane technology [Internet]. Noyes Publications; 1990.

### OBSERVATIONS

The proposed Teaching Plan may have minor modifications, to be discussed with students.