IPS Instituto Politécnico de Setúbal
Escola Superior de Tecnologia do Barreiro

Curriculum Unit Sheet

Advanced Transport Phenomena

Academic Year:

2018/2019

Course	Master's degree on Chemical and Biological Engineering								
Scientific Area	Processes in Chemical and Biological Engineering								
ECTS Credits	7	**Curriculum Unit code**	MEBQ003	**Year**	1	**Semester**	1	**Type**	Compulsory
Prerequisites									

Contact Hours

Lecture Sessions		**Lecture-Practical Sessions**	60	**Practical and Laboratory Sessions**	
Tutorial		**Placement**		**Seminar**	
Fieldwork		**Other**		**Autonomous Study**	129

Responsible	Maria de Lurdes de Figueiredo Gameiro	**Position**	Invited Assistant Professor
Lecturers	Maria de Lurdes de Figueiredo Gameiro	**Position**	Invited Assistant Professor

Learning Outcomes

This curricular unit aims to deepen and consolidate the knowledge about the mass, heat and momentum transfer acquired during the undergraduate studies. It is intended that students understand the general equations of conservation, knowing how to apply the various methods for the simplification of these equations, adapting them to different processes and conditions in the industry.

Students must also learn to solve more complex forms of these equations using numerical methods of resolution. It is still a goal of this curricular unit to introduce concepts about the simultaneous transfer of mass, momentum and energy, particularly for phenomena in multiphase flows, enabling students to understand and solve complex problems involving gas-liquid-solid flows.

Syllabus

1. Review of concepts applied to transfer phenomena.
2. Application to the transfer phenomena of the rotational, divergence, gradient and Laplacian operators. Mass, movement and energy conservation differential equations. Fluid motion Navier-Stokes equation. Applications of the Laplace and Fourier transforms to the general conservation equation. Numerical resolution of general conservation equations.
3. Multiphase flow: introduction and definitions. Flow patterns. Flow Maps. Head loss in pipes: homogeneous models and separate phases, kinematic models, correlations applied to flow of oil and gas. Heat and mass transfer. Instrumentation and measurements. Differential formulation of local instant equations. Differential formulation of mean equations: two-phase diffusion / slip model and homogeneous model. Constitutive equations. Phase distribution. Transients. Modeling flow patterns and their transitions.

Teaching Methodologies

Theoretical classes with lecturing periods and application examples followed by small tasks to be performed by the students in order to consolidate the contents previously taught. Practical classes dedicated to problem solving, individually or in small groups.

Evaluation

Assessment will have a component based on a final written exam (100%). Assessment based on continuous evaluation is performed by two tests of equal value, which corresponds to 60% of the final grade. A written work with an oral presentation (English language) must be delivered by groups of students. The assignment must be about the application of the curricular unit content to a specific industrial process. This work corresponds to 40% of the final evaluation.

Evidence of the syllabus coherence with the curricular unit's intended learning outcomes

The curricular unit starts with a brief review of the concepts taught in undergraduate studies regarding transfer phenomena. The contents are then divided into two major groups. Chapter 2 will analyze the concepts of mass, moment and energy transport phenomena using the general differential equations of conservation (Navier-Stokes). This approach allows students to be aware that the different applications of transport phenomena result from a broadening and comprehensive model implemented for specific conditions. Therefore, students grasp a more general and abstract view of such contents. In this chapter some analytical and numerical resolution methods of the general differential equations of conservation with practical applicability in the industry are taught, allowing the students to understand that the equations applied to concrete cases results from simplifications of the general equations. In the 3rd chapter of this curricular unit, advanced transport phenomena contents are taught, namely the ones used in more complex industrial processes, i.e., multiphase flows. This chapter will address the basic principles of the analysis of gas-liquid-solid flows.

Evidence of the teaching methodologies coherence with the curricular unit's intended learning outcomes

For this curricular unit it is essential to allow students to acquire advanced knowledge of transfer phenomena, which lets them have a more comprehensive view of the various industrial problems involving these contents.

Students should have previously learned in an undergraduate course, the basic knowledge of transfer phenomena. This will allow that these advanced contents are apprehended in a rigor, firm and consistent way; consequently, these contents must be taught by lecturing.

Consolidation of this knowledge must be done in practical classes by solving exercises by teachers and by students individually, this being the reason why a significant number of classes of a practical nature must be lectured.

A significant part of the bibliography is published in English, therefore it is essential that during the lecture the technical terms must also be taught in English and the students are required to perform work and presenting them in English (oral and written form).

Bibliography

1. "Transport Phenomena", Revised 2nd Edition, R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot, John Wiley & Sons, ISBN-10: 0470115394, 2006.
2. "Fundamentals of Momentum, Heat and Mass Transfer", 5th Edition, James Welty, Charles E. Wicks, Gregory L. Rorrer and Robert E. Wilson, John Wiley & Sons, ISBN-13: 978-0470128688, 2007.
3. "Fundamentals of Multiphase Flow", Christopher E. Brennen, Cambridge University Press, ISBN-13: 978-0521139984, 2009.
4. "Multiphase Flow Analysis Using Population Balance Modeling: Bubbles, Drops and Particles", Guan Heng Yeoh e Dr. Chi Pok Cheung and Jiyuan Tu, Butterworth-Heinemann, ISBN-13: 978-0080982298, 2013.
5. "The Flow of Complex Mixtures in Pipes", George Wheeler Govier, 2nd edition, Society of Petroleum, ISBN-13: 978-1555631390, 2008.

Observations