COURSE DATA

Data Subject	
Code	44432
Name	Transport phenomena
Cycle	Master's degree
ECTS Credits	4.5
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
2209 - M.D. in Chemical Engineering	School of Engineering	1	First term

Subject-matter

Degree	Subject-matter	Character
2209 - M.D. in Chemical Engineering	5 - Transport phenomena	Obligatory

Coordination

Name	Department
ALVAREZ HORNOS, FRANCISCO JAVIER	245 - Chemical Engineering

SUMMARY

The subject ***Transport Phenomena*** is part of the subject matter ***Processes and Product Engineering***, the general aim of which is that the students acquire the basic principles of the chemical engineering for subsequent application to the design and analysis of the operation of chemical reactors and unit operations of the process industry. It is a compulsory subject that is taught quarterly basis in the Master in Chemical Engineering in the first quarter and taught in Spanish. The curriculum consists of a total of 4.5 ECTS.

This course aims to go more deeply into the basis of momentum, heat and mass transfer processes, by introducing two fundamental tools for the chemical or physical process analysis and design: microscopic balances and rate equations, so much for the molecular transport and for the turbulent processes. The necessary theoretical aspect of the matter complements with a big practical component in which, after the introduction of the basic concepts, the students will realise numerous exercises of application.

The **general objectives** of the course are:

- To deepen in the laws governing the momentum, heat and mass transfer in any physical or chemical process, to tackle then the equipment design of the chemical process industry.

- To develop in students the ability to pose and solve numerical problems in transport phenomena, and to interpret the results.

- To enhance the student's skills in reasoning and systematic work.

The course **contents** are:

- Conservation and change equations. Rate equations.
- Design equations in molecular and turbulent transport.
- Boundary Layer Theory.
- Analogies between transport phenomena.
- Application to the resolution of practical cases.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

The students with a BSc degree in Chemical Engineering do not need any additional requirements.
The students from other degrees should have the following skills:
- To be familiar with rectangular, cylindrical and spherical coordinates systems.
- Know how to perform operations between scalars, vectors and tensors and know how to solve systems of equations.
- To be familiar with the concept of reaction rate and to possess basic knowledge of thermodynamics.
- To be familiar with the balances approach and basic concepts of unit operation and transport process.

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OUTCOMES

2209 - M.D. in Chemical Engineering

- Students should apply acquired knowledge to solve problems in unfamiliar contexts within their field of study, including multidisciplinary scenarios.
- Students should demonstrate self-directed learning skills for continued academic growth.
- Students should possess and understand foundational knowledge that enables original thinking and research in the field.
- Lead and define multidisciplinary teams which can make technical changes and address managerial needs in both national and international contexts.
- Be able to apply the scientific method and the principles of engineering and economics to formulate and solve complex problems in processes, equipment, facilities and services in which matter changes its composition, state or energy content, these changes being characteristic of the chemical industry and of other related sectors such as pharmacology, biotechnology, materials science, energy, food or the environment.
- Conceive, plan, calculate and design processes, equipment, industrial facilities and services in the field of chemical engineering and other related industrial sectors in terms of quality, safety, economics, rational and efficient use of natural resources and environmental conservation.
- Know how to establish and develop mathematical models by using appropriate software in order to provide the scientific and technological basis for the design of new products, processes, systems and services and for the optimisation of others already developed.
- Integrate knowledge and handle the complexity of formulating judgments and decisions, based on incomplete or limited information, which take account of the social and ethical responsibilities of professional practice.
- Communicate and discuss proposals and conclusions in specialised and non-specialised multilingual forums, in a clear and unambiguous manner.
- Adapt to changes and be able to apply new and advanced technologies and other relevant developments with initiative and entrepreneurship.
- Have skills for independent learning in order to maintain and enhance the specific competences of chemical engineering which enable continuous professional development.
- Be able to access information tools in different areas of knowledge and use them properly.
- Be able to assess the need to complete their technical, scientific, language, computer, literary, ethical, social and human education, and to organise their own learning with a high degree of autonomy.
- Be able to defend criteria with rigor and arguments and to present them properly and accurately.
- Be able to take responsibility for their own professional development and specialisation in one or more fields of study.

- Design products, processes, systems and services for the chemical industry and optimise others already developed, on the basis of the technologies of various areas of chemical engineering including transport processes and phenomena, separation operations and engineering of chemical, nuclear, electrochemical and biochemical reactions.
- Apply critical reasoning to their knowledge of mathematics, physics, chemistry, biology and other natural sciences, obtained through study, experience and practice, in order to establish economically viable solutions to technical problems.
- Conceptualize engineering models; apply innovative methods in problema solving and applications suitable for the design, simulation, optimization and control of processes and systems.

- Be able to solve unfamiliar and ill-defined problems that have specifications in competition by considering all possible methods of solution, including the most innovative ones, and selecting the most appropriate, and correct implementation by evaluating the different design solutions.

LEARNING OUTCOMES

1. To know the laws governing the momentum, heat and mass transfer processes in physical or chemical processes.
2. To identify and explain the physical meaning of each of the terms in the equations of microscopic property balances.
3. To identify and describe the rate equations of molecular transport processes.
4. To know how to approach and solve problems on laminar fluid motion and molecular heat and mass transfer.
5. To know how to explain the distinguishing characteristics of laminar and turbulent flow.
6. To know how to approach the rate equations for interphase transport.
7. To understand the main models that explain the dependence of the transport coefficients with the physical and flow properties of the systems.
8. To know and use the analogies between different transport phenomena.
9. To know how to approach and solve numerical problems on heat and mass transfer between phases.

DESCRIPTION OF CONTENTS

1. INTRODUCTION. MICROSCOPIC PROPERTY BALANCES

Transport Phenomena in Chemical Engineering. Transport mechanisms. Microscopic balances of property.

2. DESIGN EQUATIONS IN MOLECULAR TRANSPORT

Rate equations. Transport property. Combination of the microscopic balance and the rate equation.

3. STEADY STATE MOLECULAR TRANSPORT

Problem-solving strategies of molecular transport at steady state. Common boundary conditions. Applying the design equations of molecular transport to the resolution of different uni, bi, and tridirectional problems.

4. UNSTEADY STATE MOLECULAR TRANSPORT

Unidirectional transport in semi-infinite media. Unidirectional transport in finite media. Spot and average concentration of property. Application to bodies of finite dimensions: Newmans method.

5. TURBULENT TRANSPORT

Introduction. Origin of turbulence. Instantaneous values, time-smoothed values and fluctuations. Time-smoothed design equations. Turbulent transport theories.

6. BOUNDARY LAYER THEORY. INTERPHASE TRANSPORT

Boundary layer theory. Individual transport coefficient. Interphase transport. Overall transport coefficients. Procedures for estimating the transport coefficients. Combining balances with the rate equations: design equations.

WORKLOAD

ACTIVITY	Hours	% To be attended
Theory classes	23,00	100
Classroom practices	22,00	100
Study and independent work	28,00	0
Preparation of evaluation activities	20,00	0
Resolution of case studies	20,00	0
TOTAL	**113,00**	

TEACHING METHODOLOGY

Theoretical activities

- Explanatory development of the subject with the student's participation in resolving specific issues.
- Carrying out individual evaluation test.

Practical activities

- Learning through problem, exercises and case studies solving for acquiring skills on different aspects of the matter.

EVALUATION

Independently of the call, the assessment will carry out by means of:

Individual face-to-face objective test consisting of one or more examinations which include both practical issues and problems. Weighting: 70%. The minimum mark of the exam will be 4.5 out of 10

Assessment of theoretical and practical quizzes and resolving problems. Weighting: 20%.

Continuous assessment of each student, based on participation and degree of involvement of students, taking into account resolving short-concept issues and problems proposed. Weighting: 10%.

In order to pass the subject, the Final Mark obtained must be equal to or greater than 5 out of 10. The final mark of the students who have not passed the course for having obtained in the exam marks less than the minimum required, will be the exam mark.

In any case, the evaluation system will be governed by the established in the Reglament d’Avaluació i Qualificació de la Universitat de València per a Títols de Grau i Màster (http://links.uv.es/7S40pjF).

REFERENCES

Basic

- Fenómenos de Transporte, R.B. Bird, W.E. Stewart, E.N. Lightfoot, Reverté, 1964
- Fundamentals of Momentum, Heat and Mass Transfer, 4th ed., J.R. Welty, C.E. Wicks, R.E. Wilson, G. Rorrer, Wiley, 2001.

Additional

- Transport Phenomena, 2nd ed. R.B. Bird, W.E. Stewart, E.N. Lightfoot, Wiley, 2002
- Transport Phenomena in Newtonian Fluids A Concise Primer. P. Olsson, Springer, 2014, e-book en UV
- Transport Phenomena : An Introduction to Advanced Topics, Larry A. Glasgow. Wiley, 2010   http://links.uv.es/xfRpQa5
- Incropera's principles of heat and mass transfer . Theodore L. Bergman, Adrienne S. Lavine. Wiley, 2017
- Fundamentals of the Finite Element Method for Heat and Mass Transfer. Perumal Nithiarasu, Roland W. Lewis, Kankanhalli N. Seetharamu. Wiley, 2016

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

Contents

Volume of work and temporary planning of teaching

Regarding the workload:

The different activities described in the Teaching Guide are maintained with the planned dedication.

Regarding the temporary planning of teaching

The material for the follow-up of the theory/practical lessons allows to continue with the temporary teaching schedule both in days and hours, both if teaching is conventional face-to-face classroom-based or not.

Teaching methodology

Theory and practical lessons will tend to the maximum possible attendance, always respecting the sanitary restrictions (50% of usual classroom capacity). Depending on the capacity of the classroom and the number of students enrolled, it may be necessary to distribute the students into two groups. In this case, the subject will be taught in classrooms with streaming teaching capacity, and there may be students attending online and in class. A rotation system will be established once the enrolment data is known, guaranteeing, in any case, that the attendance percentage of all the students enrolled in the subject is the same.

Once the enrolment data is available and the availability of spaces is known, the Academic Committee of the Master will approve the Teaching Model of the Máster and its adaptation to each subject, establishing the specific conditions in which it will be taught.

If there is a closure of the facilities for health reasons that totally or partially affects the classes of the subject, these will be replaced online sessions following the schedules established by synchronous video conferencing, or, if not possible, asynchronous.

Evaluation

The evaluation system described in the Teaching Guide of the subject in which the different evaluable activities have been specified as well as their contribution to the final mark of the subject is maintained.

If there is a closure of the facilities for health reasons that affect the development of any face-to-face evaluable activity of the subject, it will be replaced by a test of a similar nature that will be carried out in virtual mode using the computer tools licensed by the University of Valencia. The contribution of each evaluable activity to the final mark of the subject will remain unchanged, as established in this guide.

Bibliography

The bibliography recommended in the Teaching Guide is kept as it is accessible and is complemented with notes, slides and problems uploaded to the Virtual Classroom as subject material.