UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

Course guide
330152 - ETFTC - Fluid Transport Engineering and Heat Transmission

Last modified: 13/11/2024

Unit in charge: Manresa School of Engineering
Teaching unit: 750 - EMIT - Department of Mining, Industrial and ICT Engineering.

Degree: BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2009). (Compulsory subject).
BACHELOR'S DEGREE IN CHEMICAL ENGINEERING (Syllabus 2016). (Compulsory subject).

Academic year: 2024 **ECTS Credits:** 6.0 **Languages:** Catalan

LECTURER

Coordinating lecturer: Guimerà Villalba, Xavier

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Know the engineering of the transport of incompressible and compressible fluids. Formulate and apply fluidization. Calculate design heat exchange equipment. Use balances of matter and energy in basic operations. Solve problems and apply them theoretical knowledge in practice. Develop the capacity for analysis and synthesis.

Transversal:
2. EFFICIENT ORAL AND WRITTEN COMMUNICATION - Level 3. Communicating clearly and efficiently in oral and written presentations. Adapting to audiences and communication aims by using suitable strategies and means.
3. TEAMWORK - Level 3. Managing and making work groups effective. Resolving possible conflicts, valuing working with others, assessing the effectiveness of a team and presenting the final results.
4. SELF-DIRECTED LEARNING - Level 3. Applying the knowledge gained in completing a task according to its relevance and importance. Deciding how to carry out a task, the amount of time to be devoted to it and the most suitable information sources.
5. GENDER PERSPECTIVE: An awareness and understanding of sexual and gender inequalities in society in relation to the field of the degree, and the incorporation of different needs and preferences due to sex and gender when designing solutions and solving problems.

TEACHING METHODOLOGY

The teaching methodology of the course includes 4 hours per week of face-to-face instruction in the classroom. The theoretical contents of the course are presented in two sections: one bimester dedicated to fluid transport and the other to heat transfer. These contents are worked on through problem-solving exercises. Autonomous student work is encouraged through the proposal of case studies that students must work on and solve throughout the course. The theoretical concepts are reinforced with the introduction of the chemical engineering simulation software Aspen-HYSYS and through the completion of two experimental practices.

LEARNING OBJECTIVES OF THE SUBJECT

OG1: Describe the transport of incompressible fluids
OG2: Identify the different mechanisms of heat transfer
OG3: Design heat exchange equipment

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	20.00
Hours medium group	30,0	20.00
Self study	90,0	60.00

Total learning time: 150 h

CONTENTS

Unit 1. INTRODUCTION

Description:
1.1. Chemical process
1.1.1. Representation of the chemical process
1.1.2. Types of chemical processes
1.2. Unit operations
1.2.1. Types of unit operations
1.2.2. Transport phenomena
1.2.3. Transport coefficients
1.2.4. Unit operations
1.3. Balance equations
1.3.1. Material balance
1.3.2. Energy balance
1.3.3. Momentum balance

Related activities:
-Theoretical classes.
- Problem-solving in class.
- Student study and autonomous work.
- Individualized student monitoring and evaluation.
- Exam 1

Full-or-part-time: 16h 40m
Theory classes: 5h
Self study : 11h 40m

Unit 2. FLUID TRANSPORT

Description:
2.1. Concept of fluid
2.2. Mass balance: continuity equation
2.3. Energy balance: Bernoulli's equation
2.4. Pumping energy and power
2.5. Frictional head losses: Newton's Law of Viscosity
2.6. Localized head losses
2.7. Centrifugal pump
2.8. Flow meters
2.9. Distribution networks

Specific objectives:
OE1: Enumerate the main characteristics of fluids
OE2: Formulate the mass balance equation for an incompressible fluid inside a pipe in steady state
OE3: Distinguish the different contributions in the energy balance of an ideal fluid and a real fluid
OE4: Explain the operation of different pumping elements
OE5: Apply Newton's law of viscosity to describe the transport of real fluids

Related activities:
- Theoretical classes.
- Problem formulation and resolution in class.
- Independent study and work by the student.
- Individualized student follow-up and assessment.
- Activity 1.
- Exam 1.

Full-or-part-time: 58h 20m
Theory classes: 25h
Self study : 33h 20m

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Unit 3. HEAT TRANSFER

Description:
3.1. Heat transfer by conduction
3.1.1. Fourier's Law
3.1.2. Heat transfer by conduction in solids
3.2. Heat transfer by convection
3.2.1. Individual convective heat transfer coefficient
3.2.2. Natural convection
3.2.3. Forced convection
3.2.4. Heat transfer with phase change
3.3. Combined heat transfer systems
3.3.1. Contact resistance
3.3.2. Conduction and convection in series
3.3.3. Conduction through two materials in parallel
3.3.4. Overall heat transfer coefficient

Specific objectives:
OE6: Enumerate the mechanisms of heat transfer
OE7: Relate Fourier's law to heat transfer by conduction
OE8: Describe heat transfer through flat, cylindrical, and spherical walls
OE9: Identify the individual heat transfer coefficients by conduction for each configuration
OE10: Solve combined heat transfer systems

Related activities:
- Theoretical classes.
- Problem formulation and resolution in class.
- Independent study and work by the student.
- Individualized student follow-up and assessment.
- Activity 2.
- Exam 2.

Full-or-part-time: 37h 30m
Theory classes: 15h
Self study : 22h 30m

Unit 4. HEAT EXCHANGERS

Description:
4.1. Double-tube heat exchanger
4.1.1. Temperature distribution
4.1.2. Design of a double-tube heat exchanger
4.2. Shell and tube heat exchanger
4.2.1. Design (F-factor method)
4.3. Phase change heat exchanger
4.3.1. Condensers
4.3.2. Evaporators

Specific objectives:
OE11: Identify the different types of heat exchangers and their modes of operation
OE12: Relate the temperature distribution and the energy balance equation of a heat exchanger
OE13: Design a double-pipe heat exchanger
OE14: Design a shell and tube heat exchanger

Related activities:
- Theoretical classes.
- Problem formulation and resolution in class.
- Independent study and work by the student.
- Individualized student follow-up and assessment.
- Activity 3.
- Exam 2.

Full-or-part-time: 37h 30m
Theory classes: 15h
Self study : 22h 30m

ACTIVITIES

ACTIVITY 1: AUTONOMOUS RESOLUTION OF A FLUID TRANSPORT'S PROBLEM

Description:
The student will be proposed a problem that must be solved individually and delivered.

Specific objectives:
OE5

Material:
Atenea Campus.

Delivery:
8.33 % of the final grade.

Full-or-part-time: 8h 20m
Self study: 8h 20m

ACTIVITY 2: AUTONOMOUS RESOLUTION OF A HEAT TRANSFER'S PROBLEM

Description:
The student will be proposed a problem that must be solved individually and delivered.

Specific objectives:
OE10

Material:
Atenea Campus.

Delivery:
8.33 % of the final grade.

Full-or-part-time: 8h 20m
Self study: 8h 20m

ACTIVITY 3: AUTONOMOUS RESOLUTION OF A HEAT EXCHANGERS'S PROBLEM

Description:
The student will be proposed a problem that must be solved individually and delivered.

Specific objectives:
OE13, OE14

Material:
Atenea Campus.

Delivery:
8.33 % of the final grade.

Full-or-part-time: 8h 20m
Self study: 8h 20m

EXAMEN 1

Description:
Resolution of a written exam related to unit 1 and 2.

Specific objectives:
OE1: Enumerate the main characteristics of fluids
OE2: Formulate the mass balance equation for an incompressible fluid inside a pipe in steady state
OE3: Distinguish the different contributions in the energy balance of an ideal fluid and a real fluid
OE4: Explain the operation of different pumping elements
OE5: Apply Newton's law of viscosity to describe the transport of real fluids

Material:
Written exam provided by the professor.

Delivery:
30 % of the final grade.

Full-or-part-time: 7h
Self study: 5h
Theory classes: 2h

GROUP PROJECT

Description:
Resolution of an industrial calculation problem using simulation software.
Oral presentation of its resolution, demonstrating mastery of the contents taught in the subject, followed by a question and answer session from the other students.

Specific objectives:
OE2, OE3, OE6, OE10, OE11, OE13, OE14

Material:
Atenea Campus.

Delivery:
15% of the final grade

Full-or-part-time: 15h
Self study: 15h

EXAM 2

Description:
Resolution of a written exam related to unit 3 and 4.

Specific objectives:
OE6: Enumerate the mechanisms of heat transfer
OE7: Relate Fourier's law to heat transfer by conduction
OE8: Describe heat transfer through flat, cylindrical, and spherical walls
OE9: Identify the individual heat transfer coefficients by conduction for each configuration
OE10: Solve combined heat transfer systems
OE11: Identify the different types of heat exchangers and their modes of operation
OE12: Relate the temperature distribution and the energy balance equation of a heat exchanger
OE13: Design a double-pipe heat exchanger
OE14: Design a shell and tube heat exchanger

Material:
Written exam provided by the professor.

Delivery:
30 % of the final grade.

Full-or-part-time: 7h
Self study: 5h
Theory classes: 2h

GRADING SYSTEM

Final mark = 60% individual written tests + 25% case study resolution + 15% group project

EXAMINATION RULES.

The activities are part of the continuous evaluation. If the student does not carry out any of the activities, it will be considered not scored.

BIBLIOGRAPHY

Basic:

- Coulson, J. M.; Richardson, J. F. Ingeniería química: unidades SI [on line]. Barcelona: Reverté, 1979-1986 [Consultation: 14/09/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=10453. ISBN 8429171347.
- Coulson, J. M.; Richardson, J. F. Ingeniería química: unidades SI. Vol. 4, Soluciones a los problemas de ingeniería química del tomo I; vol. 5, Soluciones a los problemas de ingeniería química del tomo II. Barcelona: Reverté, 1979-1986. ISBN 8429171347.
- Levenspiel, O. Flujo de fluidos e intercambio de calor [on line]. Barcelona: Reverté, 1993 [Consultation: 08/06/2022]. Available on: https://www-ingebook-com.recursos.biblioteca.upc.edu/ib/NPcd/IB_BooksVis?cod_primaria=1000187&codigo_libro=8184. ISBN 8429179682.

Complementary:

- Perry, R. H.; Green, D. W., eds. Perry's chemical engineers' handbook [CD-ROM]. New York: McGraw-Hill, 1999. ISBN 0071344128.
- Perry, Robert H.; Green, Don W., eds. Perry's chemical engineers' handbook [on line]. 8th ed. New York: McGraw-Hill, 2008 [Consultation: 10/06/2022]. Available on: https://search-ebscohost-com.recursos.biblioteca.upc.edu/login.aspx?direct=true&AuthType=ip,uid&db=nlebk&AN=219494&site=ehost-live&ebv=EB&ppid=pp_C. ISBN 9780071593137.

RESOURCES

Other resources:

- Bonsfills , A. Enginyeria del transport de fluids i transmissió de calor: recull de dades. Manresa: EPSEM, 2021.