VNIVERSITAT DE VALÈNCIA

Course Guide
34765 Chemical Engineering Laboratory III

COURSE DATA

Data Subject	
Code	34765
Name	Chemical Engineering Laboratory III
Cycle	Grade
ECTS Credits	4.5
Academic year	2020 - 2021

Study (s)

Degree	Center	Acad. year	Period
1401 - Degree in Chemical Engineering	School of Engineering	4	First term

Subject-matter

Degree	Subject-matter	Character
1401 - Degree in Chemical Engineering	18 - Experimentation in chemical engineering	Obligatory

Coordination

Name	Department
LLADOSA LOPEZ, ESTELA	245 - Chemical Engineering
VERCHER MONTAÑANA, ERNESTO	245 - Chemical Engineering

SUMMARY

The subject Chemical Engineering Laboratory III is a four-monthly compulsory subject taught in the fourth year of the Degree in Chemical Engineering. In the curriculum of the University of Valencia has a total of 4.5 ECTS credits, which represent a total number of working hours of 112.5 hours, 67.5 contact hours and 45 non-contact hours.

The subject is a part of the same name matter, key in the Chemical Engineering curriculum due to the importance that it has in the knowledge and management of equipments that are part of chemical industrial processes.

The course is eminently practical. The overall objective is to familiarize with experimental methods related to the study of Basic Operations of mass transfer. For this purpose, the student must:

- Develop experimental studies of varying degrees of difficulty in facilities similar to that existing in chemical process industry.
- Handle with precision differents devices and equipment.
- Perform experimental measurements with accuracy and precision.
- Proceed methodically in carrying out the calculations.
- Proceed methodically in carrying out tables and graphs.
- Manage industrial simulators.
- Write in a clear and organized way a written report.

- Prepare a clear and organized display.
- Make an oral exposure in a clear and organized way.
- Critically analyze the results of an experiment.

The **contents** of this subject are related to the design and experimentation in the field of chemical engineering, especially focussed to the study of Basic Operations of mass transfer.

Observations: The practical classes will be taught in Spanish or Valencian as stated in the course information available on the website of the degree.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

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

Other requirements

To successfully overcome the course is essential that the student possesses a number of chemical engineering previous knowledge that it must have been acquired in previous courses with subjects as Bases of Chemical Engineering, Process and Products Engineering and the student must be registred in the subject Unit Operations of Chemical Engineering.

OUTCOMES

1401 - Degree in Chemical Engineering

- G4 - Ability to solve problems with initiative, decision-making skills, creativity and critical reasoning and to communicate and transmit knowledge, abilities and skills in the field of industrial engineering.
- G5 - Knowledge to carry out measurements, calculations, assessments, appraisals, surveys, studies, reports, work plans and analogous work.

- G10 - Ability to work in a multilingual and multidisciplinary environment.
- TE1 - Knowledge of material and energy balances, biotechnology, matter transfer, separation operations, chemical reaction engineering, reactor design, and valorisation and transformation of raw materials and energy resources.
- TE3 - Ability to design and manage applied experimental procedures, especially for determining thermodynamic and transport properties, and modelling of phenomena and systems in the field of chemical engineering, systems with fluid flows, heat transfer, matter transfer operations, kinetics of chemical reactions and reactors.

LEARNING OUTCOMES

Learning results

- Manage different equipment and devices of industrial application. (Outcome G5)
- Take measures with accuracy and precision. (Outcome G5)
- Propose experimental devices to understand and apply the basic principles of chemical engineering. (Outcomes G4, G5, TE1 and TE3)
- Operate equipment in facilities of the chemical process industry. (Outcomes G4 and G5)
- Analyze equipment, assess their adequacy and propose alternatives. (Outcomes G4 and G5)
- Select and apply the most appropriate mathematical methods to get results from the experimental data obtained in the laboratory. (Outcomes G5 and TE1)
- Critically analyze the results obtained by performing laboratory practices. (Outcomes G4, TE1 and TE3)
- Write clearly, understandably and organized reports of work done in the laboratory. (Outcomes G5, G10 and TE1)
- Find, select and understand the information in specialized literature sources. (Outcome G4)
- Acquire ability to work in groups. (Outcome G10)

Skills to acquire

The the student should be able to:

- Determine experimental data of vapor-liquid equilibrium of a binary mixture.
- Understand the operation of a trayed rectification column.
- Apply the McCabe-Thiele method for calculating the overall efficiency of a trayed rectification column.
- Apply the Fenske method to calculate the overall efficiency of a trayed rectification column.
- Analyze the influence of steam flow rate on the individual efficiency and overall efficiency of a trayed rectification column.
- Understand the operation of a packed rectification column.
- Apply the McCabe-Thiele method to calculate the HETP of a packed rectification column.
- Apply the mass transfer rate equations to calculate the mass transfer coefficient in a a packed rectification column.
- Determine the influence of the steam flow on the the HETP of a packed rectification column.
- Determine the influence of the vapor stream flow on the mass transfer coefficient in a packed rectification column.
- Understand the operation of a drying unit.

- Determine the influence of the air stream temperature on the drying process rate.
- Determine the influence of the air stream flow on the drying process rate.
- Apply the diffusion model to estimate the water diffusion coefficient through a solid material.
- Understand the operation of a water cooling column with air.
- Use the design equations of water-air interaction to calculate heat and mass transfer coefficients.
- Analyze the influence of water and air flows of on the transfer of matter and energy in a water cooling column with air.
- Understand the operation of an adsorption column.

- Determine the breakthrough curve and the breakthrough time.
- Analyze the influence of the feed rate to an adsorption column on the breakthrough curve.
- Understand the operation of an absorption column.
- Describe the phenomenon of flooding.
- Calculate the surface area of Raschig rings packing.
- Use the design equations of an absorption column to calculate the mass transfer coefficients.
- Analyze the influence of water and gas flows on mass transfer in an absorption column.
- Manage the simulator Aspen Hysys ®.
- Consult literature for obtaining experimental data of EVL and other thermodynamic properties.
- Perform the calibration of a chromatograph.
- Use the calibration of the chromatograph and the results of the chromatographic analysis to determine the composition of a sample.
- Use mass flow controllers to regulate the flow of a process stream.
- Prepare and write properly a written report.
- Develop and properly expose an oral exposure.

In addition to the specific objectives mentioned above, during the course will be encouraged the acquisition of several **social and technical skills**, among these it could be included:

- Capacity for analysis and synthesis.
- Ability to interpret relevant data.
- Ability to communicate ideas, problems and solutions.
- Ability to argue from rational and logical criteria.
- Ability to plan and develop an experiment in a systematic and organized way.
- Ability to express oneself in a correctly and organized way.
- Ability to develop a written report in a clear and organized way.
- Ability to develop an oral exposure in a clear and organized way.
- Ability to critically analyze the results of an experiment.
- Ability to work independently.
- Ability to integrate and actively participate in group tasks.
- Ability to properly distribute time to the development of individual and group tasks.

DESCRIPTION OF CONTENTS

1. Introduction to the subject Chemical Engineering Laboratory III

Description of the subject: objectives, contents, learning outcomes, activities and time planning, methodology and evaluation system.

2. Trayed rectification columns

Study of the operation of a trayed rectification column. Experimental determination of the vapor liquid equilibrium of a binary mixture. McCabe-Thiele method for calculating overall efficiency. Fenske method for calculating overall efficiency. Calculation of the individual efficiency. Influence of the vapour flow on the values of individual and overall efficiency.

3. Packed rectification columns

Study of the operation of a packed rectification column. Experimental determination of the vapor liquid equilibrium of a binary mixture. McCabe-Thiele method for HETP calculation. Calculation of the mass transfer coefficient. Influence of the vapour flow on the values of HETP and mass transfer coefficient.

4. Absorption in packed columns

Study of the operation of a packed absorption column. Flooding phenomenon. Calculation of the filling specific surface. Calculation of the mass transfer coefficients. Influence of the liquid phase and the gas phase flows on the mass transfer rate.

5. Drying process

Study of the operation of a drying column. Influence of the air stream temperature in the drying process rate. Influence ot the air flow in the drying process rate. Application the diffusion model to estimate the water diffusion coefficient through a solid material.

6. Air-water interaction

Study of the operation of a cooling water column with air. Application of the design equations to calculate the mass and energy transfer coefficients. Influence of the feed rates of air and water in the values of the coefficients of mass and energy transfer.

7. Adsorption

Study of the operation of an adsorption column. Experimental determination of the breakthrough curve and the breakthrough time: influence of the feed flow rate.

8. Simulation of chemical processes

Description and training to use Aspen Hysys® simulator. Resolution of case studies. Practical application of the knowledge and skills to the design, simulation and optimization of processes.

9. Oral exposure

Oral exposure of one of the practices developed in the laboratory: fundamentals, experimental device, design of experiments, results and conclusions.

10. Visits to industrial installations

First contact with installations of two industrial processes of products development.

WORKLOAD

ACTIVITY	Hours	% To be attended
Laboratory practices	45,00	100
Classroom practices	22,50	100
Development of group work	32,00	0
Development of individual work	5,00	0
Study and independent work	4,00	0
Preparation of evaluation activities	4,00	0
TOTAL	**112,50**	

TEACHING METHODOLOGY

The development of the course is organized around six themes: attendance to laboratory sessions, attendance to the simulation sessions, industrial site visits, seminars, conducting programmed works and non programmed tutorial lessons.

Students will complete one introductory laboratory session, 8 laboratory sessions 4.5 h each one, five simulation sessions (16.5 h), two visits to industrial installations, an oral exposure and a practical exam (which include both the simulation part and the laboratory part) according to the programmed timetable for each group. Attendance at all the above activities is obligatory and necessary to overcome this subject.

The laboratory practices will be made in groups of two students. Each pair of students will perform in the laboratory the experimental part of four of the six practices listed in section *Description of Contents* of this guide in two consecutive sessions of 4.5 hours each. The main competences worked with these activities will be G4 and G5.

Before entering the laboratory, students will know in good time the practices to realize. They will have a script of each practice in the e-learning platform “Aula Virtual” of the University of Valencia which could be downloaded. The experiments will be conducted entirely by students under teacher supervision in the laboratory 4.0.7 of Chemical Engineering Department.

Prior to conductig the experimental session, students will individually answer a questionnaire about the practice in question to check the level of preparation.

In addition, each pair of students must submit a written report of each of the practices. The reports will have a compulsory deadline previously established. Report submittion is a necessary condition for overcoming this subject. The main competences worked with these activities will be G4, G5, G10, TE1 and TE3.

Simulation sessions also will be made in groups of two studentes. Four sessions of three hours each and one session of 4.5 h have been programmed for each group, according to the timetable of the group the students belong to. The main competences worked with these activities will be G4, G5, G10 and TE1.

With respect to the seminars, in the first one the rules for the proper organization of the subject, the methodology and evaluation system will be explained, and practical partners will be stablished. In the second seminar students will expose individually to the group one of the practices conducted in the laboratory. For the preparation of the exposure they will have the guidance and supervision of the teachers of the subject. The main competence worked with this activity will be G4.

The planned dates for performing visits are not confirmed because they depend on the availability of the installation to visit. Students will be informed in good time the date once it will be concretize through e-mail.

All the work proposed to the students will be divided into three types: Questionnaires, written reports and oral exposure. Questionnaires will be done at the start of each practice, and written reports and oral exposure will have a timetable for completion and submittion.

EVALUATION

Assistance to laboratory and simulation sessions, industrial site visits, the delivery of reports of the practices, performing oral exposure, performing questionnaires and exam are obligatory and necessary for overcoming this subject.

The final mark of the course will be obtained from the note of the reports of practices and oral exposure (60%), the note of the questionnaires (10%) and the exam of the laboratory part (10%) and the note of the exam of the simulation part (20%). For overcomig the subject the mark of each of the reports and the exam of the laboratory must be higher than 40 points, the average mark of the reports must exceed 50 points and also the mark of the simulation exam must exceed 50 points. It will be necessary to obtain a final mark of at least 50 points to overcome the subject.

Students who have failed this subject in the first round by not attending the laboratory sessions (G4 and G5) or simulation will not have another chance to pass it. Since, laboratory and simulation sessions are a non-recoverable and obligatory activity for the course to be passed.

Students who have failed this subject in the first call for not having obtained a minimum of 40 in the lab exam or 50 in the simulation exam (G4, G5, G10 y TE1) will have the chance to approve on the second call by retaking the corresponding exam on the date it will be established. Students who have failed this subject in the first call for not having obtained a minimum of 50 on the average mark of the reports will have the chance to approve on the second call by repeating written reports of the practices (G4, G5, G10, TE1 i TE3) with a mark lower than 50 and / or performing oral exposure again (G4). If students haven´t got a minimum final mark of 50 they must retake the exam on the second call.

To apply for advanced call, student must have done all the compulsory activities definied in the teaching guide.

Anyhow, the evaluation system will be based on the guides stated in the “Reglament d’Avaluació i Qualificació de la Universitat de València per a Graus i Màsters” (https://goo.gl/UdDYS2).

REFERENCES

Basic

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Additional

- Holland, C.D.
  Fundamentals and Modeling of Separation Processes: Absorption, Distillation, Evaporation and Extraction. Prentice-Hall, Englewood Cliffs (1975).
  Traducción al castellano: Fundamentos y Modelos de Procesos de Separación. Prentice-Hall, Internacional (1981).

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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

The contents initially indicated in the course guide are maintained.

Workload and temporary teaching planning

Regarding the workload:

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

Regarding the temporary teaching planning:

The material to the follow-up of classroom practice classes and laboratory sessions allows to continue the temporary teacher planning both days and hours, whether the teaching is face-to-face in the classroom or not.

Teaching Methodology

In practical lessons in the classroom (simulation sessions) there will be the maximum possible attendance, always respecting the sanitary restrictions that limit the capacity of the classrooms to 50% of their usual occupation. If the number of students enrolled exceeds the classroom capacity limit, it may be necessary to distribute students into two groups in certain sessions that necessarily require face-to-face. If this situation arises, each group will attend the sessions of classroom practices with physical presence in the classroom in rotating turns, thus guaranteeing the fulfilment of the criteria of occupation of spaces. The rotation system will be fixed once the actual tuition data is known, guaranteeing, in any case, that the percentage of face-to-face of all students enrolled in the subject is the same. For non-face-to-face classroom practice sessions, a preferably synchronous online teaching model will be used, provided that compatibility with other scheduled activities allows. Online teaching will be developed by synchronous

videoconferencing according to the schedule, or, if not possible, asynchronous.

With regard to laboratory practices, attendance at scheduled sessions will be fully face-to-face.

Once the actual registration data is available and the availability of spaces is known, the Academic Commission of the Degree will approve the Teaching Model of the Degree and its adaptation to each subject, establishing in that model the specific conditions under which the teaching of the subject will be developed.

If there is a closure of the facilities for health reasons that totally or partially affects the classes of the course, the simulations sessions will be replaced by non-face-to-face sessions following the established schedules and using the tools of the virtual classroom. Laboratory session will be replaced by simars for the processing of experimental data, given the impossibility of having a non-face-to-face alternative to achieve the objective of learning the management and interpretation of the operation of experimental devices.

Evaluation

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

If there is a closure of the facilities for sanitary reasons affecting 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 grade of the subject will remain unchanged, as set out in this guide.

References

The literature recommended in the Course Guide is maintained since part of it is accessible, and it is complemented by notes and additional material uploaded to the Virtual Classroom as material of the subject.