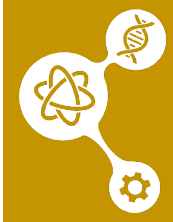
Academic year
2026/2027

Course Guide:

MECHANICAL ENGINEERING



FACULTY OF
CHEMICAL SCIENCES

1. IDENTIFICATION

Degree Programme	Bachelor's Degree in Chemical Engineering.			Course Code	801553
Course Name	Mechanical Engineering			ECTS	6
Subject Area	Engineering Bases				
Module	Industrial Engineering				
Course Type	Compulsory	Year	Fourth Year	Semester	First Semester
Department	Chemical and Materials Engineering				

Teaching Staff

Activity	Lecturer	Email	Office
Lectures/Seminars/Tutorials	FERNANDO ALFARO BURGOS	feralfar@ucm.es	QB-547

2. OBJECTIVES

General objective

Integrate the knowledge previously acquired about Process Engineering and apply it to the design of equipment and facilities, identifying the habitual functions of the Chemical Engineer in their professional performance and establishing procedures for their coordination with other specialist engineers.

It is recommended that the student have a basic level of English that allows them to handle bibliography in English, search for information, and communicate in writing and orally in that language.

Specific objectives

- Differentiate concepts of Process Design and Mechanical Design in industrial plants projects.
- Prepare and/or interpret documentation involved in the design: datasheets, specifications, engineering drawings, and vendor documentation.
- Know and handle the most widely used design codes and standards in the design process equipment.
- Establish general criteria for the development of implementation plot plans and routings of piping networks.
- Recognize frequently used technical vocabulary and acronyms and their Spanish-English equivalence.

3. PRIOR KNOWLEDGE AND RECOMMENDATIONS

Prior knowledge

The proper follow-up of this course requires that the student has previously acquired the knowledge and skills corresponding to the following subjects: Fundamentals of Chemical Engineering, Applied Graphic Expression, Fluid Mechanics, Process Engineering and Thermal Engineering. Even though enrolment is not formally conditioned by this prior

learning, effective mastery of above-mentioned knowledge is essential to follow this course with reasonable possibilities of achievement.

Recommendations

It is recommended that the student have a basic level of English that allows them to handle bibliography in English, search for information and communicate in writing and orally in that language. Likewise, it is recommended that they be familiar with computer tools and programs for solving complex problems, as well as applications for writing, editing, and presenting technical reports. Furthermore, for a better capitalization of the course, it is recommended to be familiar with process flow diagrams, other types of diagrams and plans, and know how to obtain the data necessary to solve a problem from a given set of data.

4. CONTENTS

Brief description

Bases of industrial design. Typology and design of equipment in Chemical Engineering: piping, pressure vessels, tanks. Datasheets. Design codes. Inspection, recyclability, and quality control. Bases of the design of facilities in the Chemical Industry. Previous documentation of the process. Flow diagrams. General services project. Site. General implementation criteria and plans. Functional, mechanical, and constructive design of services.

Course syllabus

1. Introduction

   Industrial plant projects. Technical disciplines. Distribution of responsibilities.

2. Documentation

   General documents. PFD (Process Flow Diagram). Material and energy balances. Process datasheets. Material selection diagrams. P&ID (Piping and Instruments Diagram). Equipment list. Mechanical datasheets. Vendor documentation. Specifications, guides, standards, etc.

3. Design and Material Conditions

   Types of equipment. Definitions. Estimation of design pressure and temperature. Preparation of DP-DT diagrams. Selection of construction materials. Types of construction materials. International standards for construction materials.

4. Plot Plan

   Basic references. General considerations. General plot plan. General criteria. ISBL and OSBL plot plans. Miscellaneous.

5. Pipes

   Specification of piping materials. Piping. Flanges. Unions and couplings. Accessories. Valves. Thermal insulation, tracing, and jacketing. Line numbering. Line list. Calculation of pipe thickness.

6. Pumps and Compressors

   Pumps and compressors: types, applications, selection, datasheets. Centrifugal pumps: parts, concepts, characteristic curves, cavitation, NPSHa and shut-off pressure calculation, accessories, auxiliaries, etc.

7. Process Vessels

Vessels, columns, and reactors: types, parts, connections, supports, internal elements, external elements, datasheets. Specifications. Mechanical design: code, conditions, definitions. Design calculations: internal and external pressure.

8. Heat Exchangers

Shell and tube exchangers, air coolers, fire furnaces. Types and classification, general features, temperature control, datasheets. Mechanical design. Thermal design. Standards.

9. Storage Tanks

Types. Datasheets. Standards. Mechanical design.

5. COMPETENCES

General competences

CG1-MII7	Use the principles of machines and mechanisms.

Specific competences

CE13-B1	Design, using codes and standards, equipment used in the chemical industry.
CE13-B2	Prepare and interpret specification sheets.
CE13-B3	Select commercial equipment.
CE13-B4	Arrange process equipment in the plant.
CE13-B5	Represent and interpret the different diagrams related to equipment and installations.

Cross-cutting competences

CT2-II1	Demonstrate capacity for analysis and synthesis in Industrial Engineering.
CT5-II1	Consult, use and analyse bibliographic sources.
CT10-II1	Integrate acquired knowledge and apply it to solving problems in Industrial Engineering.

6. WORKLOAD DISTRIBUTION BY ACTIVITY

Activity	In-class (hours)	Self-study (hours)	Credits
Lectures/Seminars/Tutorials	45	82,5	5,1
Tutorials / Guided work	1	9	0,4
Coursework and examination preparation	4	8,5	0,5
Total	**50**	**100**	**6**

7. METHODOLOGY

In the theoretical classes the student will be made aware of the content of the subject. At the beginning of each topic, the main content and objectives will be clearly stated. At the end of the topic, a brief summary of the most relevant aspects will be made, and new objectives will be proposed that will allow the contents already studied to be interrelated.

During the presentation of contents, problems will be proposed that exemplify the concepts developed or that serve as an introduction to new content. To facilitate the student's monitoring of face-to-face classes, the teaching material used by the teacher will be provided only on the Virtual Campus. The presentation of each of the topics will be done using the blackboard and PowerPoint-type image presentations. Part of the recommended bibliography and practically all of the support material that is available in the Virtual Campus for the development of the teaching activities of this subject will be in English.

Simultaneously with the development of each topic, practical cases will be proposed to be solved during classes through student work in small groups and their subsequent sharing.

In the guided work part, students must submit several exercises similar to those developed in class, which will be evaluated.

Tutorials will preferably be scheduled with small groups. In them, the doubts raised by the students will be resolved and they will be guided with explanations and bibliographic recommendations.

The Virtual Campus will be used to allow fluid communication between teachers and students and as an instrument to make the material that will be used in classes available to students.

8. BIBLIOGRAPHY

Basic bibliography

- Ludwig, Ernest E.: "*Applied process design for chemical and petrochemical plant*", Gulf Professional Publishing.
- "*Engineering Data Book*", Gas Processors Suppliers Association.
- Moss, Dennis R.: "*Pressure Vessel Design Manual*", Gulf Professional Publishing.

Complementary bibliography

- ASME Boiler & Pressure Vessel Code.
- API Standard 650. Welded Steel Tanks for Oil Storage.
- API Standard 620. Design and Construction of Large, Welded, Low-Pressure Storage Tanks.
- Standards of the Tubular Exchanger Manufacturers Association.
- API Standard 660. Shell-and-tube Heat Exchangers for General Refinery Services.
- API Standard 661. Air-cooled Heat Exchangers for General Refinery Service.
- API Standard 560. Fired Heaters for General Refinery Service.
- ASME Code for Pressure Piping, B31 (ASME B.31.3 Process Piping)
- API Standards 610, 674, 675, 676 (Pumps)
- API Standards 617, 618, 619 (Compressors)
- ASME B36.10M. Welded and Seamless Wrought Steel Pipe.
- ASME B36.19M. Stainless Steel Pipe.
- "*The Steam and Condensate Loop*", Spirax Sarco Limited.

9. EVALUATION

The student's academic performance and the final grade of the subject will be computed in a weighted manner based on the following percentages, which will be maintained in all calls:

- **WRITTEN EXAMS: 70%**

  A final exam will be taken for the entire subject. In this exam, theoretical and practical questions related to the subject's syllabus will be proposed.

  Competencies evaluated: CG1-MII7, CE13-B1, CE13-B2, CE13-B3, CE13-B4, CE13-B5, CT2-II1, CT5-II1, CT10-II1.

- **GUIDED WORKS: 30%**

  Students must submit various practical exercises similar to those developed in class. The exercises will be evaluated both from an objective point of view (correct results), and from the point of view of the appropriate approach to the problem and the development of calculations for its resolution. The issuance of hypotheses and assumptions for solving the problem, as well as the proposal of alternatives, will be positively valued.

  Competencies evaluated: CG1-MII7, CE13-B1, CE13-B2, CE13-B3, CE13-B4, CE13-B5, CT2-II1, CT5-II1, CT10-II1.

The final course grade will be calculated as the weighted average of the different assessable activities. However, to pass the course, students must obtain the minimum grade established for each activity. If this requirement is not met, the final grade will be the weighted average, capped at 4.5 out of 10. This criterion shall apply to both the ordinary and extraordinary assessment periods.

The evaluations of exams and class activities that may be graded will be communicated to the students preferably within a period of two weeks from their completion and in any case, ten days before the date of the final exam of the subject, so that the student can adequately plan the study of this or other subjects.

Assignments scheduled for delivery on the same day of the exam will be graded simultaneously with the exam.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Introduction	Lectures / Seminars	2	1	1st Week	1st Week
2. Documentation	Lectures / Seminars	2	1	1st Week	2nd Week
3. Design Conditions & Materials	Lectures / Seminars	12	1	2nd Week	6th Week
4. Plot Plans	Lectures / Seminars	3	1	6th Week	7th Week
5. Piping	Lectures / Seminars	3	1	**7th Week**	8th Week
6. Rotative Equipment	Lectures / Seminars	12	1	8th Week	12th Week
7. Process Vessels	Lectures / Seminars	4	1	12th Week	13th Week
8. Heat Exchanger	Lectures / Seminars	4	1	13th Week	14th Week
9. Storage Tanks	Lectures / Seminars	3	1	15th Week	15th Week
	Tutorials*	1	1	15th Week	15th Week

* Tutorials scheduling depends on the global planning of the course subjects.

SUMMARY OF ACTIVITIES

TEACHING ACTIVITY	ASSOCIATED COMPETENCES	TEACHING ACTIVITY	STUDENT ACTIVITY	EVALUATION	P	NP	TOTAL	C
Lectures / Seminars / Tutorials / Guided works	CG1-MII7. CE13-B1, CE13-B2, CE13-B3, CE13-B4, CE13-B5. CT2-II1, CT5-II1, CT10-II1.	Exposition of theoretical concepts. Approach to practical cases related to the theory and their resolution. Student orientation with explanations and bibliographic recommendations.	Taking notes. Formulation of questions and doubts. Discussion and resolution of practical cases. Resolution and delivery of practical exercises related to theory, similar to those proposed in class.	Qualification of the practical cases proposed for delivery. Assessment of attitude and initiative.	46	91,5	137,5	**30%**
Exams	CG1-MII7. CE13-B1, CE13-B2, CE13-B3, CE13-B4, CE13-B5. CT2-II1, CT5-II1, CT10-II1	Proposal, supervision, and correction of the exam. Student qualification.	Preparation and realization.	Correction and assessment.	4	8,5	12,5	**70%**

P: In-class activities

NP: Non-classroom activities (self-study)

C: Assessment weighting