FACULTAD DE CIENCIAS QUÍMICAS

DESIGN AND IMPLEMENTATION OF A PROJECT IN CHEMISTRY

COURSE GUIDE

BSc Chemistry

Academic Year 2026-2027

UNIVERSIDAD COMPLUTENSE MADRID

I.- IDENTIFICATION

COURSE NAME:	**Design and Implementation of a project in Chemistry**
CREDITS (ECTS):	**6**
CHARACTER:	**Compulsory**
SUBJECT:	**Writing and execution of a project in Chemistry**
MODULE:	**Advanced**
DEGREE:	**Degree in Chemistry**
SEMESTER/QUARTER:	**First (fourth year)**
DEPARTMENT/S:	**Chemical Engineering and Materials**

COORDINATOR:

Lectures Seminars Tutorials	**Lecturer:**	VIRGINIA ALONSO RUBIO
	Department:	Chemical Engineering and Materials
	Office:	QB-534
	e-mail:	valonso@ucm.es

LECTURERS:

Grupo A		
Lectures Seminars Tutorials	**Lecturer:**	MARÍA MARTÍN MARTÍNEZ
	Department:	Chemical Engineering and Materials
	Office:	QA-154
	e-mail:	mariam74@ucm.es
Lectures Seminars Tutorials	**Lecturer:**	VICTORIA RIGUAL HERNÁNDEZ
	Department:	Chemical Engineering and Materials
	Office:	QB-547A
	e-mail:	vicrigua@ucm.es
Grupo B		
Lectures Seminars Tutorials	**Lecturer:**	RUBÉN MIRANDA CARREÑO
	Department:	Chemical Engineering and Materials
	Office:	QB-531-B
	e-mail:	rmiranda@quim.ucm.es
Grupo C		
Lectures Seminars Tutorials	**Lecturer:**	VIRGINIA ALONSO RUBIO
	Department:	Chemical Engineering and Materials
	Office:	QB-534
	e-mail:	valonso@ucm.es

Grupo D		
Lectures **Seminars** **Tutorials**	**Lecturer:** **Department:** **Office:** **e-mail:**	ANTONIO TIJERO CRUZ Chemical Engineering and Materials QB-501 atijero@ucm.es
Lectures **Seminars** **Tutorials**	**Lecturer:** **Department:** **Office:** **e-mail:**	SARA MATEO FERNÁNDEZ Chemical Engineering and Materials QB-547A smateo04@ucm.es

II.- OBJECTIVES

GENERAL OBJECTIVE

This course will introduce the student to the methodology, direction, management and organization of projects in the field of Chemistry. The final objective will be to develop a project in Chemistry in which the student relates the knowledge acquired in Chemistry, Chemical Engineering and other subjects related to Chemistry. After completing the course, the student should be able to write, plan, execute and manage industrial projects in chemistry.

SPECIFIC OBJECTIVES

- To acquire the basic concepts related to projects in Chemistry.
- To know the theory of the project and the structure and contents of the documents that compose it.
- To know the organization, management and project direction procedures.
- To show the student the legislative and regulatory framework in which the task of projecting in the field of chemistry is carried out.
- To ratify the possibility of placing the product to be developed by the project on the market by conducting a market study.
- To analyze the factors that influence the decision on the size of the project, the procedures for its calculation and the criteria for seeking its optimization.
- To know the main criteria and techniques for evaluating the location of a project.
- To define and describe the optimal production process for the efficient and effective use of available resources to obtain the product of interest.
- To analyze and assess the environmental impact of the project.
- To provide the student with knowledge of the applicable Industrial Safety Regulations and how to integrate them into the project.
- To analyze how the information provided by the market, technical, and organizational studies allows defining the project investments.
- To know the essential items of production costs and their applications to the field of project study.
- To analyze the main techniques for measuring the profitability of a project.

- To develop the capacity for teamwork.
- To acquire skills in preparing well-structured and well-written technical reports and their presentation using the most common audiovisual media.

III.- PREVIOUS KNOWLEDGE AND RECOMMENDATIONS

PREVIOUS KNOWLEDGE:

Inorganic and organic chemistry. Applied chemical kinetics. Chemical processes of industrial interest. General concepts of Chemical Engineering. Basic operations. Separation operations. Mechanical properties of materials.

RECOMMENDATIONS:

To take this course properly, having passed the *Basic Subjects* and the *Fundamental Module* is advisable.

IV.- CONTENTS

BRIEF DESCRIPTION:

Methodology, direction, management and organization of projects. Standards, regulations and legislation. Feasibility study. Process engineering. Economic study and budget. Industrial safety. Environmental impact. Preparation and presentation of technical reports.

SYLLABUS:

1. **Engineering projects.** Definition, objectives, classification and characteristics of projects. Project life cycle. Documents. Legal aspects and regulations. Project environment agents. Scope, planning and scheduling. Execution and control. Quality, risk, procurement and contracting management.
2. **Preparation and presentation of technical reports.** Definitions. Characteristics of the technical report. Contents. Structure. Style standards. Teamwork. Oral presentation of technical reports. Audiovisual media.
3. **Market research.** Market definition. Market structure. The project's market. Objectives of the market study. Structure of the market analysis. Supply, demand and price analysis. Stages of the market study. Market projection techniques.
4. **Project size.** Factors that determine the size of a project. Initial project size alternatives. Project size optimization. Elasticity of demand and supply. Economics of scale. Optimal project capacity. Coefficients of utilization: critical production and closing production. Capacity of a project with increasing demand.
5. **Location.** Objectives of the location study. Location factors. Location evaluation techniques.

6. **Basic project engineering.** Process selection and evaluation. Basis of design. Fundamentals of integrated process design. Energy integration. Process diagrams. Material and energy balances. Equipment lists. Distribution of process equipment in plant**.**
7. **Project investments.** Investment concept. Item of machinery and equipment. Fixed assets: Composition and estimation methods. Working capital: Composition and estimation methods.
8. **Production costs.** Concept of cost. Cost distribution. Manufacturing costs. Management costs.
9. **Economic evaluation of projects.** Value of money through the time. Depreciation/Amortization. Inflation. Taxes. Cash flows. Profitability. Sensitivity and uncertainty analysis.
10. **Safety in the chemical industry.** Industrial safety. Historical data. Definitions and basic concepts. Types of accidents and sequence. Prevention and protection. Safety management in the chemical industry. Emergency plans. Legislation.
11. **Environmental impact of chemical processes.** Environmental analysis of the life cycle of the process. Sources of waste emissions in the Chemical Industry. Strategies for waste minimization. Green chemistry. Environmental costs. Legislation.

V.- COMPETENCES

GENERAL:

- **CG7-MA1:** Apply theoretical and practical knowledge to solve problems in Chemistry and select the most appropriate method for it.

SPECIFIC:

- **CE32-MAP1:** Explain the theory of the project and the structure and contents of the documents that compose it.
- **CE32-MAP2:** Describe the organization, management and project direction procedures.
- **CE32-MAP3:** Ratify the possibility of placing the product by conducting a market study analyzing how this study, together with the technical and organizational studies, allows defining the project's investments.
- **CE32-MAP4:** Analyze the factors that influence the decision on the project's size, the procedures for its calculation, and the criteria to seek its optimization. Recognize the main criteria and techniques for evaluating the location of a project.
- **CE32-MAP5:** Define and describe the optimal production process for the efficient and effective use of available resources to obtain the product of interest.

- **CE32-MAP6:** Describe the essential items of production costs and their applications to the project study and analyze the main techniques for measuring the profitability of a project.
- **CE32-MAP7:** Analyze the main techniques for measuring project profitability.

■ **CROSS-DISCIPLINARY:**

- **CT1-MA1:** Prepare and write scientific and technical reports.
- **CT2-MA1:** Teamwork.
- **CT3-MA1:** Learning how to make decisions concerning a real practical problem.
- **CT4-MA1:** Select the most appropriate method to solve a given problem.
- **CT5-MA1:** Consult, use and analyze any bibliographic source.
- **CT5-MA2:** Manage bibliography and specialized databases and resources accessible through the Internet.
- **CT7-MA1:** Use computer programs that serve, in Chemistry, to calculate, design, simulate, approximate and predict.
- **CT11-MA1:** Develop autonomous work.
- **CT12-MA1:** Develop sensitivity to environmental issues and environmental preservation.
- **CT14-MA1:** Communicate in English using the most common audiovisual media.

VI. – WORKING HOURS DISTRIBUTED BY ACTIVITY

A total of 6 ECTS credits are established throughout the course. Following the criterion of 25 hours of student work/credit, the working hours' distribution is as follows:

Activity	Attendance (hours)	Self-study (hours)	Credits/ hours
Lectures	37.5	52.5	3.6
Seminars / Guided work	7.5	22.5	1.2
Tutorials	4	6	0.4
Written assignments and exams preparation	4	16	0.8
Total	**53**	**97**	**6**

VII.- METHODOLOGY

A mixed methodology will be followed based on cooperative learning, collaborative learning and self-learning. This methodology will be developed through lectures, seminars and scheduled tutorials:

- Lectures will be given to the whole group. They will be master lessons in which the complete syllabus will be exposed orderly. The content and main objectives will be clearly stated at the beginning of each unit. At the end of the unit, a summary of the most relevant contents will be articulated, including new objectives that will allow relating contents already studied. The most appropriate material will be provided to the students to help them follow the lecture. The exposition of each topic will be done using the blackboard and PowerPoint presentations. Lectures will satisfy all the specific competencies from CE32-MAP1 to C32-MAP7.
- Seminars will be given to the entire group with a double purpose. First, to deepen in some specific aspects of the subject treated in the lectures. To this end, students will work on resolving practical cases related to developing projects and process units. Also, students will practice how to search, analyze, and discuss specific bibliography. As a second objective, the seminars will be used to present and discuss the partial and final results of a chemical plant design project that the students will carry out in small teams during the course. This project will be evaluated as an autonomous work activity. Seminars will deepen the specific competencies and satisfy the general competence CG7-MA1 and the transversal competencies CT2-MA1, CT3-MA1, CT4-MA1, CT14-MA1 and CT12-MA1.
- Tutorials with small groups will be scheduled to solve the doubts raised by the students during the autonomous completion of the tasks necessary for the development of the team project and the course study. The guided work will allow the development of the transversal competencies CT1-MA1, CT5-MA1, CT5-MA2, CT7-MA1 and CT11-MA1.

The **Virtual Campus** will allow fluid communication between the professor and the students and as a tool to make available the material to be used both in the lectures and the seminars.

VIII.- BIBLIOGRAPHY

- **BASIC:**
  - Sapag Chain, N. y Sapag Chain, R., *"Preparación y Evaluación de Proyectos"*, 5ª ed., Ed. McGraw-Hill Interamericana, 2008.
  - Miranda, R. (editor). "*Ingeniería de Procesos: diseño e integración de procesos químicos*", 1ª ed., Ed. Dextra, 2020.
  - Cabra, L., de Lucas, A., Ruiz, F., Ramos, M.J., "*Metodología del diseño aplicado y gestión de proyectos para ingenieros químicos*", Ed. Univ. Castilla-La Mancha, 2010.
  - González, A., Alba, F., Ordieres, J., "*Ingeniería de proyectos*", 1ª ed., Ed. Dextra, 2014.

- de Cos Castillo, M., *"Teoría General del Proyecto. Volumen I: Dirección de Proyectos"*, 1ª ed., Ed. Síntesis, 1999.
- de Cos Castillo, M., *"Teoría General del Proyecto. Volumen II: Ingeniería de Proyectos"*, 1ª ed., Ed. Síntesis, 1998.

COMPLEMENTARY:

- Vian, A., *"El Pronóstico Económico en Química Industrial"*, 1ª ed., Ed. Eudema, 1991.
- Storch de Gracia, J. N. y García, T., *"Seguridad Industrial en Plantas Químicas y Energéticas"*, 2ª ed., Ed. Díaz de Santos, 2008.
- Smith, R. *"Chemical Process Design and Integration"*. 2ª ed., John Wiley & Sons, 2010.
- Peters, M. S., Timmerhaus, K. D. y West, R. E., *"Plant Design and Economics for Chemical Engineers"*, 5ª ed, Ed. McGraw-Hill, 2003.
- Turton, R., Bailie, R.C., Whiting, W.B., Schaeiwitz, J.A., Bhattacharyya, D. "*Analysis, Synthesis and Design of Chemical Processes*", 4ª ed., Prentice Hall, 2012.
- *"Ullman's Encyclopedia of Chemical Technology"*, 6ª ed., Ed. Wiley-VCH, 2002.
- *"Kirk-Othmer Encyclopedia of Chemical Technology"*, 4ª ed., Ed. Wiley, 2001.
- Perry, R.H. y Green, D., *"Perry's Chemical Engineer's Handbook"*, 7ª ed., Ed. McGraw-Hill, 1998.

IX.- ASSESSMENT PROCEDURE

The final grade will be calculated as the weighted average of the assessed activities. However, in order to pass the course, it will be necessary to achieve the minimum mark established for each of them. If this requirement is not met, the final grade will be the weighted average obtained, with a maximum of 4.5 out of 10.

WRITTEN EXAMS: 60%

The final exam will contribute 60% to the final qualification. The exam will consist of theoretical and practical questions related to the course syllabus, the seminars, and the project, evaluating competencies CG7 and CE32. Obtaining a minimum score of 5 out of 10 will be an essential requirement in the final exam.
In the extraordinary call, a similar exam to the one given in the ordinary call will be held.

SELF-WORK AND GUIDED ACTIVITIES: 40%

The evaluation of the self-work done by the students will be made taking into account the following:

- Work done during the scheduled group tutorials of compulsory attendance, for which students will be periodically summoned throughout the course. The unjustified

absence of the student to any of the scheduled tutorials will result in a 0 out of 10 in that tutorial.

- Presentation of a chemical plant design project. In small teams, the students will elaborate and expose (orally) the project of a chemical plant (proposed by the professor). The neatness, clarity, depth and correctness in the presented report's contents, spelling and writing, and the clarity in the exposition during the oral defense of the work will be evaluated. It is essential that the project has a minimum grade of 5 out of 10 for this activity to contribute to the overall grade of the subject. Students with a lower qualification will have to re-elaborate the project for the extraordinary call.
- A written exam will be conducted with the final exam. The exam constitutes 10% of the overall 40% assigned to the self-work and guided activities component (tutorials and the project). It is essential to achieve a minimum grade of 5.0 out of 10.0 in this written exam.

The competencies assessed in this activity will be: CG7-MA1, CT1-MA1, CT2-MA1, CT3-MA1, CT4-MA1, CT5-MA1, CT5-MA2, CT7-MA1, CT11-MA1, CT12-MA1, CT14-MA1.

The marks obtained in the activities (tutorials and final project report) will be communicated to the students soon enough before the final exam to let the students adequately plan the study of this or other subjects.

A minimum of seven days between the publication of the marks and the date of the final exam will be scheduled, except for the project qualification, since the project's delivery date coincides with the course's final exam date.

■ ATTENDANCE AND ACTIVE PARTICIPATION:

Attendance to all face-to-face activities is mandatory. The student's active participation in the activities will be positively valued for the final qualification. Repeated absence and lack of attention during the activities may be penalized. To access the final evaluation of the course, it will be necessary that the student has participated in at least 70 % of the face-to-face activities.

ACTIVITY SCHEDULE

UNIT	ACTIVITY	HOURS	GROUPS	START	END
1. Engineering projects	Lectures	3.5	1	1st week	2nd week
	Seminars	1	1		
2. Preparation and presentation of technical reports	Lectures	2	1	2nd week	2nd week
3. Market research	Lectures	3	1	3rd week	3rd week
4. Project Size	Lectures	3	1	4th week	5th week
	Seminars	1	1		
5. Location	Lectures	2	1	5th week	5th week
6. Basic Project Engineering	Lectures	6	1	6th week	8th week
	Seminars	1	1		
7. Project Investments	Lectures	4	1	8th week	9th week
8. Production costs	Lectures	3	1	9th week	10th week
9. Economic evaluation of projects	Lectures	4	1	10th week	12th week
	Seminars	1.5	1		
10. Safety in the chemical industry	Lectures	3	1	12th week	13th week
11. Environmental impact of chemical processes	Lectures	4	1	13th week	14th week
Presentation and defense of the project	Seminars	3	1	14th week	15th week
	Tutorials*	4	2	4th, 7th, 9th, and 12th weeks	

* The scheduled tutorials are subject to possible modifications according to the planning of the rest of the course subjects.

SUMMARY OF ACTIVITIES

Teaching activity	Associated competences	Lecturer activity	Student activity	Assessment procedure	P	NP	Total	C
Lectures	CE-32	Presentation of theoretical concepts.	Attention and active participation in the development of the class.	Written exam.	37.5	52.5	90	--
Seminars	CG7-MA1. CT1-MA1, CT2-MA1, CT3-MA1, CT4-MA1, CT5-MA1, CT5-MA2, CT7-MA1, CT11-MA1, CT12-MA1, CT14-MA1	Expansion of theoretical concepts and resolution of practical cases. Elaboration and proposal of works.	Discussion and resolution of case studies. Presentation and defense of the project carried out by the team.	Written exam.	4.5	2.5	7	--
Guide activities				Assessment of the answers and solutions provided by the students. Evaluation of the presentation and defense of the project. Written examination of the seminars/ exam of workshops and directed work.	3	20	23	40%
Tutorias	CE-32, CT1-MA1, CT2-MA1, CT3-MA1, CT4-MA1, CT5-MA1, CT5-MA2, CT7-MA1, CT11-MA1, CT12-MA1, CT14-MA1	Help the student with explanations and bibliographic recommendations.	Ask about the conceptual and methodological difficulties encountered when studying the subject.		4	6	10	
Exams (theory)	CE-32, CG7	The proposal, proctoring and correction of the exam. Qualification of the student.	Exam preparation and examination.	Qualification of the exam.	4	16	20	60%
P: In-class; NP: Self-study; C: Evaluation								