

# Master in Chemical Engineering

## Course information

Year 2019-20

| GENERAL SPECIFICATIONS  |                  |                        |                  |                           |
|---|------------------|------------------------|------------------|---------------------------|
| <b>English name</b>   |                  |                        |                  |                           |
| Lubricant Technology  |                  |                        |                  |                           |
| <b>Spanish name</b>   |                  |                        |                  |                           |
| Tecnología de Lubricantes                                       |                  |                        |                  |                           |
| <b>Code</b>   |                  | <b>Type</b>            |                  |                           |
| 1180109   |                  | Optative               |                  |                           |
| <b>Time distribution</b>  |                  |                        |                  |                           |
|   | <b>Total</b>     | <b>In class</b>        | <b>Out class</b> |                           |
| Working hours   | 112,5            | 45                     | 67,5             |                           |
| <b>ECTS: 4.5</b>  |                  |                        |                  |                           |
| <b>Standard group</b>   |                  | <b>Small groups</b>    |                  |                           |
|   | <b>Classroom</b> | <b>Lab</b>             | <b>Practices</b> | <b>Computer classroom</b> |
| <b>1.8</b>  | 1.5              | 0.8                    | 0.4              | 0                         |
| <b>Departments</b>  |                  | <b>Knowledge areas</b> |                  |                           |
| Ingeniería Química, Química Física y Ciencias de los Materiales |                  | Ingeniería Química     |                  |                           |
| <b>Year</b>   |                  | <b>Semester</b>        |                  |                           |
| 1º  |                  | 2º                     |                  |                           |

| TEACHING STAFF             |                           |           |        |
|----------------------------|---------------------------|-----------|--------|
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|                            |                           |           |        |

| SPECIFIC INFORMATION OF THE COURSE   |
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| <b>1. Contents description</b>   |
| 1.1. In English:   |
| Principles and fundamental of lubrication.<br>Concepts on Tribology.<br>Lubricating oils.<br>Lubricating greases.<br>Physical and Chemical Properties of lubricating oils and greases.<br>Manufacturing of lubricants.<br>Industrial Applications  |
| 1.2. In Spanish  |
| Principios y fundamentos de la lubricación. Conceptos de Tribología. Aceites lubricantes. Grasas lubricantes. Propiedades físico-químicas de aceites y grasas lubricantes. Procesos de obtención y acondicionamiento de lubricantes. Aplicaciones. |
| <b>2. Background</b>   |
| 2.1. Situation within the Degree:  |

Within the industry, lubricants play a fundamental role in the energy consumption of different machinery. We can find lubricants in all industrial sectors (chemical industry, food industry, agriculture, transport, aeronautics) with the aim of reducing friction and wear of the moving parts of machines, as well as increase the long-life service of the mechanisms. The subject Lubricant Technology is part of the intensification in "Engineering of Products derived from the Petrochemical Industry" within the item "Engineering of Processes and Chemical Products" This course provides the theoretical and practical knowledge needed to Address the problem of lubrication, such as:

- Principles and fundamentals of lubrication.
- Tribology concepts.
- Lubricant oils.
- Lubricating greases.
- Properties and physic-chemical characterization of lubricating oils and greases.
- Manufacturing and conditioning of lubricants.
- Applications

#### 2.2. Recommendations:

A basic formation of chemical processes is recommended.

### 3. Objectives (as result of teaching):

The general objective of the subject is to deepen the study of the different types of lubricants, as well as their manufacturing, physic-chemical characterization and the rheological and tribological behaviour thereof. For this purpose, the next specific objectives were followed:

- Develop technical skills to estimate, evaluate and interpret physical-chemical properties and models related to lubricants.
- Know the principles and fundamentals of lubrication, in order to distinguish the types of friction, wear and regimes of lubrication.
- Acquire knowledge about the chemistry of lubricant bases and their additives.
- Become familiar with standardized tests (ASTM standards) for lubricating oils and greases.
- Understand how the composition, microstructure, manufacture and physic-chemical properties of lubricants influence the rheological and tribological behavior of lubricating greases.
- Know the processes of obtaining and conditioning the lubricants.
- Know the main applications of lubricating oils and greases.

### 4. Skills to be acquired

#### 4.1. Specific Skills:

- CEGOP4: Adapt to structural changes in society motivated by factors or phenomena of a nature economic, energetic or natural, to solve the problems arising and provide technological solutions with a high commitment to sustainability.
- CEPP4: Have the ability to solve problems that are unfamiliar, incompletely defined or that have competing specifications, considering the possible solution methods including the most innovative, selecting the most appropriate and being able to correct the implementation, evaluating the different design solutions.
- CEPP5: Direct and supervise all types of facilities, processes, systems and services of the different areas industrial related to chemical engineering.
- CEPP6: Design, build and implement methods, processes and facilities for the integral management of supplies and waste, solids, liquids and gaseous, in industrial, with capacity to assess their impacts and their risks.
- CEGOP2: Direct and manage the organization of work and human resources applying security criteria industrial, quality management, occupational risk prevention, sustainability and environmental management.

#### 4.2. General Skills:

- CB7: That the students know how to apply the acquired knowledge and their ability to solve problems in new or little-known environments within broader (or multidisciplinary) contexts related to their area of study.
- CB9: That the students know to communicate their conclusions and the knowledge and last reasons that support them to specialized and non-specialized publics in a clear and unambiguous way.
- CG01: Ability 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 the matter undergoes changes in its composition, state or energy content, characteristic of the chemical industry and other related sectors among which are the pharmaceutical, biotechnological, materials, energy, food or environmental.
- CG05: Know how to establish mathematical models and develop them through appropriate computing, as a scientific basis and technology for the design of new products, processes, systems and services, and for the optimization of others and developed.
- CG06: Be able to analyze and synthesize the continuous progress of products, processes, systems and services using criteria of safety, economic viability, quality and environmental management.
- CT1: Properly manage the information acquired by expressing advanced knowledge and demonstrating, in a context of scientific and technological research or highly specialized, a detailed understanding and based on the theoretical and practical aspects and the methodology of work in the field of study.
- CT3: Develop an attitude and a capacity for permanent search for excellence in academic work and in the future professional exercise.

| <b>5. Training Activities and Teaching Methods</b>   |
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| <b>5.1. Training Activities:</b>   |
| <ul style="list-style-type: none"> <li>• Theory sessions on the contents of the Program.</li> <li>• Problem Solving sessions.</li> <li>• Practical sessions in specialized laboratories or computer rooms.</li> <li>• Field sessions to approach the industrial reality.</li> <li>• Activities Academically Directed by the Faculty: seminars, conferences, development of works, debates,</li> <li>• collective tutorials, evaluation activities and self-evaluation.</li> </ul>                      |
| <b>5.2. Teaching Methods:</b>  |
| <ul style="list-style-type: none"> <li>• Participatory Master Class.</li> <li>• Development of Practices in Specialized Laboratories or Computer Classrooms in small groups.</li> <li>• Development of Field Practices in small groups.</li> <li>• Problem solving and practical exercises.</li> <li>• Individual or Collective Tutorials. Direct interaction teachers-students.</li> <li>• Approach, Realization, Tutoring and Presentation of Works.</li> <li>• Conferences and Seminars.</li> </ul> |
| <b>5.3. Development and Justification:</b>   |

\* Theory sessions on the contents of the Program: Exhibition of contents through presentation or explanation by part of the teaching staff. Development of examples on the blackboard or with the help of audiovisual media.

\* Problems Resolution Sessions: Resolution of problems, exercises and practical cases related to the theoretical contents, made in large or small groups, including exercises with specific software.

\* Specialized Laboratory Practical Sessions: Practical activities carried out in small groups in laboratories specialized on the contents of the subject.

Work in small groups:

- Development of Jobs. Activity in which a theoretical-practical work is proposed to facilitate the acquisition of the skills. This work can be done individually or in groups. The presence of this activity will be carried out in the sessions dedicated to the advice and orientation of these works, as well as in the

Sessions dedicated to public exhibition and defense if they so require.

- Conferences and Seminars. To strengthen the knowledge acquired in this type of activity, students They will be able to make summaries and answer short questionnaires related to the topic proposed in The seminars / conferences.

\* Resolution and delivery of problems / practices: The student must present a work plan according to the requirements of the corresponding practice for which a prior exercise of analysis of the problem posed in practice must be carried out; It must also organize, plan and make decisions in relation to the different alternatives for solving the

practical, acquiring the ability to adapt to new alternatives or modifications in the initial approach of the practice. The teacher will indicate activities and tasks to develop (calculation or experimental) depending on the progress carried out by the working group. The final report should not be only an exhibition of the results obtained, in this a discussion of the aforementioned data must be carried out with the corresponding critical reasoning.

\* Evaluations and Exams. Various methodologies can be used to carry out the evaluation of knowledge: exams of responses to be developed, exams of short answers, self-evaluation exercises, etc.

## 6. Detailed Contents:

### BLOCK I

UNIT 1. BASIC PRINCIPLES OF LUBRICATION

### BLOCK II

UNIT 2\_ BASIC BASICS OF LUBRICATING OILS

UNIT 3\_ QUIMICATION OF LUBRICATING BASES

UNIT 4\_ ADITIVOS PARA OIL LUBRICANTES

UNIT 5\_ PROCESSES OF OBTAINING LUBRICANT BASES

### BLOCK III

UNIT 6\_ BASIC BASIS OF LUBRICATING FATS

UNIT 7\_ TECHNOLOGY OF LUBRICATING FATS

UNIT T 8\_ PROCESSES OF OBTAINING LUBRICANT FATS

### BLOCK IV

UNIT 9\_ PHYSICAL-CHEMICAL CHARACTERIZATION OF LUBRICANTS

### BLOCK V

UNIT 10\_ Applications

## 7. Bibliography

### 7.1. Basic Bibliography

- P.R. Albarracín. Tribología y Lubricación Industrial y Automotriz. Ed. LITOCHOA. Bucaramanga. 2000.

- E. Crespo, Los lubricantes y sus aplicaciones, 1972.
- Rudnick, L.R. Synthetics, mineral oils and bio-based lubricants. 2006. CRC Press.
- T. Mang and W. Dresel, Lubricants and lubrication, 2001 Wiley-VCH,
- B.O. Jacobson, Rheology and Elastohydrodynamic Lubrication, Elsevier, 1991.
- C. Balan, The Rheology of Lubricating Greases, ELGI, 2000.
- Lubricating grease guide, National Lubricating Grease Institute, Third Edition, 1994.
- Alfa-Laval, Recommendations for Pretreatment and Cleaning of Heavy Fuel Oil, 1980.
- J. Benlloch María, Los lubricantes. Características. Propiedades. Aplicaciones, 1991
- B. Bhushan, Principles and Applications of Tribology, John Wiley & Son, Inc, 1999
- Kirk-Othmer, Enciclopedia de Tecnología Química, 2001
- U.S. Army Corps of Engineers, Engineering and Design- Lubricants and Hydraulic Fluids, Washington, 1999
- Rudnick, L.R. Lubricant Additives. Chemistry and Applications. 2009. CRC Press
- Davim, J.P. Tribology for Engineers. A practical guide. 2011. Woodhead Publishing

**7.2. Additional Bibliography:**

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- .....
- .....

**8. Systems and Assessment Criteria**

**8.1. System for Assessment:**

- Theory / problems exam
- Defense of homework and Reports
- Individual Student Tracking
- Exam of practices

**8.2. Assessment Criteria and Marks:**

- Examination of theory / problems and practices, where the student exposes the sequential acquisition of skills of a theoretical-practical nature. The acquisition of CB7, CB9, CG01, CG05, CG06, CT1 competences will be especially encouraged. There will be a written exam at the end of the semester with questions of theory, problems and practitioners. The global qualification of the exam will represent 40% of the global qualification of the subject; and this will always add up and when it is higher than 3.5 out of 10.

- Examination of practices: Exam with questions about the physical-chemical characterization activities carried out during laboratory works. The competences CB7, CB9, CG1, CG5, CG6 and CT1 will be evaluated. This item represents 10% of global qualification of the subject.

- Defence of homework and written reports. Within this category, tasks and practical cases will be carried out. Activities to extend knowledge on specific subjects may be proposed. These activities are based on individual or team work on a specific topic, which must be previously delivered and set forth with participation from each of the team members. The ability of each student to work as a team, the quality of the written work (clear and justified exposure of the contents) and the oral presentation (clear exposure and communication skills), according to the objectives of the activity, the ability of analysis and synthesis of the bibliography used, as well as coordination among team members. In this sense, the competences CEGOP4, CEPP4, CB9, CG06, CT1, CT3 will be evaluated. This item represents 30% of global qualification of the subject.

- Active participation in lectures (theory / problems / practices) and practical activities. Attitude, work in class / practices will be valued, as well as the commitment on the part of the students to assimilate continuously the knowledge. In this sense, the competences will be evaluated: CEGOP4, CEPP4, CEPP5, CB7, CT1 and CT3. This item represents 20% of global qualification of the subject.

The subject will be considered approved when a global score is obtained, sum of all the previous ones, of 5 points over 10.

Those students who cannot attend class regularly or cannot carry out the academically directed activities (and is sufficiently justified), will perform a single final exam that will consist of a question of knowledge-practices and problems. The exam will be passed with a score higher than 5 out of 10.

For the September and December exams, there will be an exam that will consist of theoretical-practical questions and will be screened with a score higher than 5 out of 10.