Universidad Zaragoza

Academic Year/course: 2022/23

60643 - Process and Product Control

Syllabus Information

Academic Year: 2022/23
Subject: 60643 - Process and Product Control
Faculty / School: 100 - Facultad de Ciencias
Degree: 540 - Master's in Industrial Chemistry
ECTS: 6.0
Year: 1
Semester: First semester
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The subject and its expected results respond to the following approaches and objectives:

The course "Process and Product Control" is a compulsory subject that is taught within the Master's Degree in Industrial Chemistry of the Faculty of Sciences. It is taught by faculty from the Department of Analytical Chemistry, and offers a broadening and deepening of the knowledge taught in the Degree in Chemistry related to the control of industrial processes. It enhances the role of Analytical Chemistry in the control of industrial processes and products, integrating itself into the generic content of the "Industrial Chemistry" master's degree.

In this subject, the student acquires competences to select and appropriately use work methodology used in solving real analytical problems that involve analytical determinations or characterization techniques related to the control of processes and products in the industry.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDGs) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/es/)in such a way that the acquisition of learning outcomes of the subject provides training and competence to contribute to some extent to its achievement:

Objetivo 4: Quality Education.

Objetivo 6: Clean Water and Sanitation.

Objetivo 7: Affordable and Clean Energy.

Objetivo 9: Industry, Innovation and Infrastructure.

1.2. Context and importance of this course in the degree

The course studies analytical instrumental techniques that are poorly developed and seen in the subjects of the Degree in Chemistry. Their possibilities are critically evaluated and compared with more established techniques. In the case of instrumental techniques that have been previously seen in related degrees, these are addressed with the aim of designing, optimizing and operating an instrumental analysis procedure applied in the control of processes or a product. Specific problems are affected depending on the type of sample or industrial scope.

1.3. Recommendations to take this course

It is recommended to have passed the subjects of the Degree in Chemistry. Although introductions of basic aspects and instrumental analytical techniques will be carried out for all students (especially useful for those who come from other degrees), the knowledge imparted in the Degree in Chemistry related to the control of industrial processes, automation, sensors and biosensors will be broadened and deepened.

2. Learning goals

2.1. Competences

Upon passing the course, the student will be more competent to ...

1. Know and apply advanced methods and procedures for the control of processes and products on an industrial scale

2. Identify, analyze and define the main elements of an analytical problem to solve it in the Chemical Industry environment.

3. Communicate conclusions and knowledge to specialized and non-specialized audiences in a clear and unambiguous way.

4. Manage, discriminate and select the sources of bibliographic information.

5. Use scientific English both to obtain information and to transfer knowledge related to analyzers in the chemical industry

6. Know and apply concepts related to the control of processes and products such as control loops, automation, process analyzers, physical sensors or chemical sensors, biosensors.

7. Identify analytical problems in the chemical industry to propose and choose the most appropriate analytical techniques for their resolution.

2.2. Learning goals

The student, to pass this course, must demonstrate the following results ...

1. Describe and apply analytical methods used in the control of processes and products in the chemical industry.

2. Correctly use the concepts related to the control of processes and products: automation, analyzers, physical sensors, chemical sensors, biosensors, management, quality, productivity.

3. Select strategies integrated into process and product control systems for simple problems that respond to quality and productivity parameters.

4. Assess the importance of Analytical Chemistry and its contribution to the quality control of the chemical laboratory and productivity.

2.3. Importance of learning goals

This course must allow students to acquire the necessary criteria to decide which should be the general design of an instrumental method or the choice of sensors based on the principles of Analytical Chemistry, in order to obtain information and optimize process control and products in the Chemical Industry, Biotechnoly or other. The student will know the main concepts of process control and will understand the basic principles of signal measurement. Through the practices of this subject the student will acquire the basic experimental skill in instrumental analysis methods and sensors and their application to the control of industrial processes. The student will also know the basic elements and systems of a feedback control system, its elements (sensors, transmitters, actuators and automatic regulators), software used and its application in different types of industries.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student must demonstrate that they have achieved the expected learning outcomes through the following assessment activities

CONTINUOUS ASSESSMENT

Controls of the different subjects of the subject will be carried out. In order for them to be averagable among them, each one of them will have to overcome a grade higher than 4 out of 10. The overcoming of these controls, together with the rest of activities in the indicated percentage, will exempt from the global examination. The percentages of the activities will be:

Control assestements: 70%

Group work (TP6): 15%

Problems and cases: 15%

The completion of the Group Work (TP6 activity) will be compulsory to pass the course.

Students who do not opt ??for continuous assessment, who do not pass the subject by this procedure, or who want to upload a grade, must take a global test of the subject in the period established for this purpose in the academic calendar, on first or second call. (June and September). Said global test will suppose 100% of the grade, and it will examine all the activities carried out during the entire semester.

The number of official exams to which the registration entitles (2 per enrollment) as well as the consumption of these exams will be adjusted to the Rules of permanence in official degrees adapted to the European Higher Education Area at the University of Zaragoza and the Regulations of Learning Assessment Standards of the University of Zaragoza. The general regulations for the design of the tests and the grading system will also be adjusted to this last regulation and, according to it, the time, place and date in which the review will be held when publishing the grades will be made public.

As indicated, and according to the Regulation of the Learning Assessment Standards of the University of Zaragoza, the student will have the right to a global test in which the skills developed in the subject will be assessed. This global test will be carried out on the date established by the examination calendar of the Faculty of Sciences.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process that has been designed for this course is based on the following:

The methodology followed in this course is oriented towards the achievement of the learning objectives. The course is planned to be done in person, it will take place during a semester fulfilling the credits. However, you can adapt your teaching activities into non-contact activities through the ADD / moodle (online tutorials, videoconferences, tutoring through forums and non-face-to-face evaluations).

The course will be developed through the teaching of master classes (TP1), practical classes, seminars and problems / cases, personalized tutorials (TP2), laboratory practices (TP3), and group work (TP6). Where possible, expert conferences and visits to industries and / or laboratories will also be held.

Students are expected to participate actively in the class throughout the semester.

Classroom materials will be available via Moodle. Further information regarding the course will be provided on the first day of class.

4.2. Learning tasks

The dedication of the student (based on the ECTS credits of the course) corresponds to the following learning activities:

This is a 6 ECTS course organized as follows:

1. Type TP1 activities: they will consist of classes that complete the theoretical program of the subject.

2. Type TP2 activities: they will consist of the study of problems and real cases dealing with the control in manufacturing processes used in the chemical industry.

3. Type TP6 activities. Students divided into small groups will prepare a specialized topic on the contents of the subject. For this, the information will be sought from scientific sources, it will be written in a report, and it will be presented in a summarized way in a public presentation. To prepare the dissertation draft, the student is expected to engage in autonomous work (use of the library, reviewing the literature, writing the draft of the dissertation and revising the draft). There will be personalized tutorials with the teacher, to monitor the autonomous work carried out.

4. Assessment tasks. A set of written and oral assignments and exams.

5. Autonomous work.

These learning activities will have the dedication of the student indicated in the table based on ECTS credits

Learning activities	Hours	% on-site
Lectures (TP1)	30	100
Problems and cases solving (TP2)	20	100
Visits to companies	5	100
Group work presentation (TP6)	5	100
Written evaluations	5	100
Study of the subjects and report preparations.	85	0

Teaching and evaluation activities will be carried out on-site unless, due to the health situation, the provisions issued by the competent authorities and by the University of Zaragoza require them to be carried out electronically or semi-electronically with reduced rotating capacity.

4.3. Syllabus

The theoretical program of the subject includes the following topics and content summary:

1. CONTROL OF INDUSTRIAL PROCESSES

Introduction to process control. Concepts and terminology. Definition and location of the elements of a control loop. Instrumentation and sensors. Process analyzers. Differences between process analyzers and analysis in the laboratory. Types of applications. Sequential and continuous processes. Process automation.

2. ANALYTICAL CONTROL OF OFF-LINE PROCESSES

Levels of automation in the industrial analytical laboratory (off-line, at-line, on-line, in-line, remote). Types of standards, quality control and examples of off-line control. LIMS systems. Automation of the analytical process. Laboratory analyzers. Stages to be automatized: sample collection, sample preparation, measurement. Injection flow analysis. Segmented and non-segmented flow. Continuous and discontinuous online analyzers. Automatic instrumental titrators. Comprehensive Automated Analyzers - Examples in Industry and Clinical Laboratories.

3. INDUSTRIAL ANALYZERS BASED ON SPECTROMETRIC TECHNIQUES

Analyzers based on molecular techniques. UV-vis absorption: quantitative aspects (Kubelka-Munk), natural gas industry, indirect methods and industrial color measurement. Near Infrared (NIR): multiparametric methods, food industry, pharmaceutical industry and other types of industries. Medium infrared (MIR): Gas analyzers, remote systems and other applications. Raman spectrometry: SERS effects, applications in pharmaceutical and biotechnology industries. Other techniques: Molecular fluorescence and dispersion. Analyzers based on atomic techniques. Neutron activation: General aspects, applications in the cement and mining industry. X-Ray Fluorescence: Fundamentals, application in the metallurgical industry and others. Other atomic instrumental techniques.

4. INDUSTRIAL ANALYZERS BASED ON ELECTROANALYTICAL AND CHROMATOGRAPHIC TECHNIQUES.

General approach. Conductimetry: applications in the chemical and energy industries. Potentiometry: pH Measurement and control in industrial processes. Voltammetry: galvanizing industry and others. Exclusion chromatography: polymer industry. Ion chromatography: analyzers for the industrial control of inorganic ions. Natural gas analyzers based on Gas Chromatography.

5. SENSORS AND BIOSENSORS IN THE CONTROL OF INDUSTRIAL AND BIOTECHNOLOGICAL PROCESSES.

Physical parameter sensors. Actuators. Chemical sensors. Sensors for flammability, toxicity and oxygen control: catalytic, electrochemical, photonic and other types. Biosensors: general aspects. Types of transduction mechanisms and immobilization of (bio) reagents. Lateral flow, acoustic, surface plasmon resonance biosensors, enzymatic and biochips. Applications of sensors and biosensors in the chemical, agri-food, clinical and biotechnology industries.

6. APPLICATIONS OF ANALYTICAL CHEMISTRY IN THE CONTROL OF INDUSTRIAL PROCESSES.

Examples of process control in the chemical industry. Examples of process control in the agri-food, pharmaceutical and biotechnology industries. Examples of control of physical parameters and chemical composition. Trends in Analytical Chemistry in Process Control Technology. Emerging areas of process control applications.

4.4. Course planning and calendar

On-site sessions and group works presentations schedule:

Further information concerning the timetable, classroom, office hours, assessment dates and other details regarding this course will be provided on the first day of class. Please refer to the calendar and timetables of the course in its face-to-face sessions found at: http://ciencias.unizar.es/web/horarios.do

The beginning and end of the course will be marked by the academic calendar of the Faculty of Sciences, taught during the first semester of the academic year.

The specific dates on which the different controls and delivery of work will take place throughout the course will be communicated to the students in advance, mainly in the first days of the course.

The global assessment tests will take place on the dates determined in the calendar of the Faculty of Sciences (consult the bulletin board or on the website: http://ciencias.unizar.es/web/horarios.do). These tests will preferably be carried out in person, although they could be carried out totally or partially through the ADD / moodle (tasks and questions) in person.

4.5. Bibliography and recommended resources

Bakeev, K.A., *Process Analytical Technology spectroscopy tools and implementation strategies for the chemical and pharmaceutical industries*, 2nd ed., Willey, 2010.

Eggins, B.R., *Chemical sensors and biosensors,* 3ª ed., John Wiley and Sons, 2004.

Velasco, F., *Analizadores de proceso en línea. Introducción a sus técnicas analíticas*, 1ª edic., Díaz de Santos, 2015.

Skoog, D.A. *et al.*, *Principios de análisis industrial*, 6ª ed., Cengage Learning, 2008.

Monsalvo, R. *et al.*, *Balance de materia y energía. Procesos industriales*, 1ª ed., Grupo editorial Patria, 2014.

Instrument and Automation Engineers?Handbook, 5ª edición, 2017, Vol I y Vol II.

Normas UNE/EN: disponibles en:

https://portal.aenormas.aenor.com/aenor/suscripciones/personal/pagina_per_sus.asp#.YqBWg5BBzao