Instrumental Chemical Analysis-1

1. GENERAL

SCHOOL	NATURAL SCIENCES		
ACADEMIC UNIT	CHEMISTRY		
LEVEL OF STUDIES	UNDERGRADUATE (BACHELOR of SCIENCE)		
COURSE CODE	**XE 353**	SEMESTER	**3rd**
COURSE TITLE	INSTRUMENTAL CHEMICAL ANALYSIS-1		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures	3	5
Seminars	1	
Laboratory work	-	
Add rows if necessary. The organisation of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialised general knowledge, skills development*	Field of Science (Analytical Chemistry)
PREREQUISITE COURSES:	There are no prerequisite courses. It is however recommended that students have basic knowledge of Qualitative analysis and Quantitative analysis.
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	Greek. However, the course can be taught in English if foreign students are enrolled.
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://www.chem.upatras.gr, http://eclass.upatras.gr

2. LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

At the end of this course the student will know:

Chromatographic Techniques in Chemical Analysis

1. The basic chromatographic parameters: Distribution constant, Retention time, Retention factor and their physical meaning. Ability to use these parameters to calculate from a chromatogram other basic parameters such as the Selectivity Factor and the Resolution.
2. The Plate theory and its basic assumptions. Calculation of the Number of Theoretical Plates from a chromatogram. The Rate Theory and van Deemter equation, with its graphical representations for Gas and Liquid Chromatography- HPLC.

3. Recognize the classes of analytes to be determined by Gas Solid and Gas Liquid Chromatography (with packed and capillary columns). Ability to select the appropriate column and detector for the separation and determination of various analytes by Gas Chromatography.
4. Recognize the various types of Liquid Chromatography-HPLC (Liquid-Solid Chromatography, Liquid-Liquid Chromatography Normal and Reverse Chromatography, Ion Chromatography and Size Exclusion Chromatography). Select the appropriate column for a certain separation and the appropriate detector for the determination of various analytes. Understand the role of the solvent in HPLC.
5. Perform Qualitative and Quantitative Analysis by chromatography employing various calibration techniques.

Electroanalytical Techniques

1. *Potentiometry.* Indicator electrodes. Development of electrical potentials. Development of membrane potentials. Reference electrodes. The liquid junction potential. Electrodes selective to molecules. Principle and architecture of potentiometric gas sensors. Principle and architecture of biocatalytic membrane electrodes. Quantitative analysis by potentiometry. Direct potentiometric methods. Calibration methods. Errors in potentiometry. Potentiometric titrations.
2. *Coulometry.* Principle of coulometric titrations. Advantages of coulometric titrations. Various types of coulometric titrations: Acid-base titrations; precipitation titrations; complex-formation titrations; oxidation reduction titrations. Electrochemical cells for coulometry. Problems.
3. *Voltammetry.* Principles of voltammetric sensors. Applications.

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*Others*
Production of new research ideas	

At the end of the course the student will have further developed the following skills/competences:

1. Ability to demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to Chromatography
2. Ability to apply such knowledge and understanding to the solution of qualitative and quantitative problems of an unfamiliar nature.
3. Ability to adopt and apply methodology to the solution of unfamiliar problems.
4. Study skills needed for continuing professional development.
5. Ability to interact with others on inter or multidisciplinary problems.
6. Propose membrane composition for potentiometric determination of various ions or molecules.
7. Predict interferences in potentiometric determinations.
8. Selection of a reference electrode.
9. Ability to develop potentiometric determinations including calibration and calculations.
10. Development of coulometric titrations.

3. SYLLABUS

1. *General Concepts of Chromatography*: Distribution Constants, Retention time, Retention Factor, Selectivity Factor, Plate Theory, Rate Theory, Van Deemter equation for Gas and Liquid Chromatography. Resolution and factors that affect the resolution.

2. *Gas Chromatography*: Instrumentation for Gas Chromatography. Carrier Gas. Solid support. Liquid Stationary Phase. Temperature programming. Capillary columns in Gas Chromatography. Adsorbents. Detectors FID, TCD and ECD.
3. *Liquid Chromatography*: Types of Liquid Chromatography. Instrumentation. Liquid-Solid Chromatography. Adsorbents. Liquid-Liquid Chromatography. Stationary phases of Liquid-Liquid Chromatography for Normal and Reverse Phases. The role of Mobile Phase. Gradient Elution. Detectors: UV/Visible, Diode Array and Refractive Index Detector. Ion Chromatography with chemical suppression. Size Exclusion Chromatography. Gel Permeation and Gel Filtration Chromatography.
4. *Qualitative and Quantitative Analysis*: Kovats Index. Quantitative analysis various calibration techniques.
5. *Electroanalytical Techniques*
6. *Potentiometry*. Indicator electrodes. Development of electrical potentials. Development of membrane potentials. Reference electrodes. The liquid junction potential. Electrodes selective to molecules. Principle and architecture of potentiometric gas sensors. Principle and architecture of biocatalytic membrane electrodes. Quantitative analysis by potentiometry. Direct potentiometric methods. Calibration methods. Errors in potentiometry. Potentiometric titrations.
7. *Coulometry*. Principle of coulometric titrations. Advantages of coulometric titrations. Various types of coulometric titrations: Acid-base titrations; precipitation titrations; complex-formation titrations; oxidation reduction titrations. Electrochemical cells for coulometry. Problems.
8. *Voltammetry*. Principles of voltammetric sensors. Applications.

4. TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Lectures
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Use of Information and Communication Technologies (ICTs) (PowerPoint) in Lectures. Course lectures and exemplary solved problems for every chapter. Seminars. Problems are solved in an exemplary way summarizing before the theory behind each problem.
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	see table below

Activity	***Semester workload***
Lectures (3 contact hours per week x 13 weeks)	39
Seminars (1 contact hour per week x 13 weeks) - solving of representative problems	13
Final written examination (3 contact hours)	3
Private study time of the student and preparation for the final examination	70
Course total	***125***

STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	One written examination at end of Semester 100% of grade. Minimum passing grade: 5.

5. ATTACHED BIBLIOGRAPHY

1. D.A. Skoog, F.J. Holler, T.A. Nieman, “Principles of Instrumental Analysis “, 6th Edition, Thomson Brooks Cole Publications, 2007.
2. Th. Hatjiioannou and M.A. Kouppari, “Instrumental Analysis, Mavrommatis Publications, 2003.
3. D. C. Harris, “Quantitative Chemical Analysis”, 8th Ed., W. H. Freeman and Company Publications, 2010.