NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES
CHEMISTRY PROGRAM

CQ412 – INSTRUMENTAL ANALYTICAL CHEMISTRY II

I. GENERAL INFORMATION

CODE	**:**	CQ412 – Instrumental Analytical Chemistry II
SEMESTER	**:**	8
CREDITS	**:**	06
HOURS PER WEEK	**:**	08 (Theory – Laboratory)
PREREQUISITES	**:**	Instrumental Analytical Chemistry I
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

The Instrumental Analytical Chemistry II course provides students with the knowledge and skills necessary to understand, choose and use the electrometric and chromatographic methods necessary for research work and very diverse fields of Chemistry.
The course develops the topics of electrometric techniques such as potentiometry, voltammetry, conductimetry and coulometry, Chromatographic analysis such as gas and liquid HPLC chromatography.

III. COURSE OUTCOMES

By the end this course the student will:

- Describe the stages of the analytical process and know how to weigh the importance of each of them.
- Apply the methodologies associated with the treatment of the sample and recognize the problems associated with it.
- Apply the basic fundamentals of the main electrochemical instrumental techniques, as well as the chromatographic techniques.
- Propose an electroanalytical or chromatographic technique suitable for the identification or quantification of a certain analyte.
- Apply basic concepts of statistics as a tool to solve analytical, metrology and quality management problems.
- Develop the ability to apply in the laboratory the main instrumental and separation techniques for the resolution of concrete analytical problems.

IV. LEARNING UNITS

1. **INTRODUCTION TO ELECTROCHEMISTRY / 4 HOURS**
   Types of Electroanalytical Methods / Electrochemical Cells / Double electric layer / Faradaic and non-faradaic currents / Liquid union Potentials / Electrode potentials. Cell potentials / Reference electrodes / Calculation of cell potentials / Nernst equation. Problems.

2. **POTENTIOMETRY / 10 HOURS**
   Introduction / Potentiometric Cell / Reference Electrodes / Types of Indicator Electrodes / Metallic Indicator Electrodes / Membrane Indicator Electrodes / Glass Electrodes / Crystal and Liquid Membrane Electrodes / Sensitive Electrodes to Molecules. Selectivity / Instrumentation / Potentiometric applications / Problems.

3. **VOLTAMETRY / 10 HOURS**
   Introduction / Polarization / Mass transport mechanism / Instrumentation / Polarography. Characteristics of the polarograms / Hydrodynamic voltammetry / Cyclic voltammetry / Voltammetric impulse methods / Applications of Voltammetry (Polarography) / Redisolution methods. Problems.

4. **CONDUCTIMETRY / 6 HOURS**
   Conduction and conductivity of electrolytes / Conductance cells / Influence of the nature of electrolyte and solvent on conductivity / Influence of concentration on conductivity / Applications of conductometric measurements.

5. **COULOMETRY / 6 HOURS**
   Introduction / Curves i - E during electrolysis / Electrogravimetric methods of analysis / Electrolysis at constant current / Electrolysis at constant working electrode potential / Potentiostatic Coulometry / Amperostatic Coulometry / Applications. Problems.

6. **INTRODUCTION TO CHROMATOGRAPHY / 4 HOURS**
   Introduction / General Description of Column Chromatography / Migration Rates of solutes. Band widening / Optimization of column efficiency / Applications / Problems.

7. **GAS CHROMATOGRAPHY / 8 HOURS**
   General principles. Instrumentation. Detectors. Columns and stationary phases. Applications. Gas chromatography / Mass spectrometry (GC / MS). Problems.

8. **LIQUID CHROMATOGRAPHY OF HPLC / 8 HOURS**
   Types of liquid chromatography / Factors involved in chromatographic separations. Instrumentation / Repartition Chromatography / Adsorption chromatography / Ion chromatography. Chromatography of size exclusion**.**

V. LABORATORIES AND PRACTICAL EXPERIENCES

Laboratory 1: Potentiometric determination of F - with selective electrode in mouthwash
Laboratory 2: Potentiometric determination of Cl - with selective electrode in rehydrating drinks
Laboratory 3: Potentiometric determination of Soft Drinks Acidity
Laboratory 4:
Laboratory 5: Determination of Pb and Cd by Anodic Redisolution Voltammetry
Laboratory 6: Conductometric Titrations
Laboratory 7: Determination of Vitamin C in fruits by Coulometric Titrations
Laboratory 8: Determination of Alcohols in alcoholic beverages by Gas Chromatography

VI. METHODOLOGY

The subject is developed in theory and laboratory sessions. In theory sessions the teacher presents the foundation of instrumental techniques, how the signal and the required instrumentation are generated. Likewise, the teacher will analyze with the students the potentialities and limitations of it. Will also show potential applications in the research and chemistry field. In the laboratory sessions the student manipulates the instruments related to the technique and materials of the laboratory and presents a laboratory report. In all the sessions, the active participation of the student is promoted.

VII. EVALUATION FORMULA

Calculation of the final grade (FG):

$$FG = \frac{1 * PE + 1 * FE + 1 * PA}{3}$$

PE: Partial Exam
FE: Final Exam.
PA: Practices Average

The PRACTICE AVERAGE (PA) is obtained as follows: Two (02) laboratory practices with the lowest grades are eliminated, by regulation, and the AVERAGE OF LABORATORY PRACTICES (ALP) of the six (06) remaining laboratory practices is obtained. The qualified practice with the lowest grade is also eliminated and the AVERAGE OF QUALIFIED PRACTICES (AQP) of the three (03) remaining qualified practices is obtained.

$$PA = \frac{1 * ALP + 1 * AQP}{2}$$

VIII. BIBLIOGRAPHY

- Skoog, D. A., Holler, F. A. y Crouch S. R., Principios de Análisis Instrumental, Cengage Learning, 6ta edición, 2008.
- Rubinson K., Rubinson J., Análisis Instrumental, Prentice Hall, 2000.
- Pingarrón, José M., Química Electroanalítica, Editorial Síntesis, 2003.
- Harvey, David, Química Analítica Moderna, Mc Graw Hill, 2002.
- Harris, Daniel C., Análisis Químico Cuantitativo, Editorial Reverté S. A., 2001.