NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF SCIENCES
CHEMISTRY PROGRAM

CQ444 – MATERIALS CHEMISTRY

I. GENERAL INFORMATION

CODE	**:**	CQ462 – Materials Chemistry
SEMESTER	**:**	8
CREDITS	**:**	05
HOURS PER WEEK	**:**	07 (Theory – Practices)
PREREQUISITES	**:**	Physical-Chemistry III
CONDITION	**:**	Mandatory

II. COURSE DESCRIPTION

Materials science is a border science between Materials Physics, Chemistry and Engineering, and has a remarkable importance for the current technological development. On the basis of the knowledge acquired in inorganic chemistry and physical-chemistry about the structure and bond in solids, a behavior interpretation of materials is developed by studying the microstructure, the defects, electronic, optical and magnetic properties that give rise to its potential technological applications. In this way, the course “Materials Chemistry " has as main objective to establish the link between the scientific base acquired in the undergraduate courses and the Materials Engineering and its various applications.

III. COURSE OUTCOMES

By the end this course the student will:

- Describe and identify the different solid materials based on their application.
- Know different techniques for characterization of solid compounds.

IV. LEARNING UNITS

1. **STRUCTURE OF CRYSTALLINE SOLIDS (6 hours)**
   Introduction to Materials Science / Materials in the history of man / From New Materials to nanomaterials / Some ways to classify materials: Structural and functional materials / Unitary cell / Crystal structure of metals / Density calculation / Polymorphism and allotropy / Crystal systems / Crystallographic directions / Planes and compact directions / Anisotropy / Determination of crystal structures by XRD.

2. **IMPERFECTIONS IN SOLIDS AND DIFFUSION IN METALS (8 hours)**
   Vacancy and impurities / Dislocations / Punctual and linear defects / Interstitial and volume defects. Surface defects, grain boundaries. Metal diffusion / Diffusion mechanisms / Stationary and non-stationary diffusion / Diffusion factors / Diffusion and material treatments.

3. **ELECTRICAL MATERIALS AND CONDUCTIVITY. MAGNETIC (8 hours)**

Electric conduction: Band models. Conductors/ Intrinsic and extrinsic semiconductors. Semiconductor devices / Superconductors: high temperature superconducting oxides. Electrical conductivity in ionic materials / Magnetic properties: Ferromagnetic, Ferrimagnetic / Antiferromagnetic.

4. **MECHANICAL PROPERTIES OF METALS (6 hours)**
   Concept of effort and deformation. Elastic deformation: inelasticity / Elastic properties of materials / Plastic deformation: Tensile and tension properties / Elastic recovery during plastic deformation / Compression deformation / Hardness.

5. **DISLOCATIONS, HARDENING AND BREAKING MECHANISMS (6 hours)**
   Dislocation concept / Dislocations characteristics / Sliding systems / Sliding in single crystals / Twinning deformation / Hardening by reduction of the grain size, by solid dissolution and by deformation.

6. **FASIC DIAGRAMS (7 hours)**
   Iron-carbon system. Phase diagram, iron - iron carbide (Fe-Fe3C) / Development of microstructures in iron-carbon alloys / Influence of other alloying elements / Microstructural and properties changes in iron-carbon alloys / Isothermal transformation diagrams / Transformation diagrams by continuous cooling / Mechanical behavior of steel.

7. **STRUCTURE AND PROPERTIES OF CERAMICS (8 hours)**
   Introduction / Crystal structures / Ceramics formed by silicates / Ceramics imperfection. Mechanical properties of ceramics / Mechanisms of plastic deformation / Glass. Thermally treated glass / Clays and their composition.

8. **POLYMERS (7 hours)**
   Classification / Polymerization reactions / Degree of polymerization / Industrial methods / Thermoplastic / Thermosetting polymers and elastomers / Mechanical properties / Stress-strain behavior / Deformation of semi-crystalline polymers / Fusion and glass transition phenomenon.

V. LABORATORIES AND PRACTICAL EXPERIENCES

Laboratory 1: Measurement of grain size by metallographic techniques

Laboratory 2: Photocatalytic synthesis and characterization of semiconductors

Laboratory 3: Silver Nanoparticles Synthesis

Laboratory 4: Obtaining cobalt spinels doped with copper

Laboratory 5: Obtaining chitosan hydrogels

Laboratory 6: Carbon materials.

VI. METHODOLOGY

The course is developed in theory, practice and laboratory sessions. In theory sessions, the teacher presents the phenomenon, concepts and applications. In the laboratory sessions the student manipulates equipment and performs synthesis of organic and inorganic compounds, then presents a report. During the course, students in groups must choose and present an integrating project that contains the topics developed in the course. In all the sessions, the active participation of the student is promoted.

VII. EVALUATION FORMULA

Calculation of the final grade (FG):

$$FG = \frac{1 * PE + 2 * FE + 1 * PA}{4}$$

PE: Partial Exam (Weight 1)
FE: Final Exam. (Weight 2)
PA: Practices Average (Weight 1)

Amount of Qualified Practices (02).
Amount of Laboratory Practices (06).

VIII. BIBLIOGRAPHY

- Callister W.D., “Materials Science and Engineering. An Introduction” 6th edition Reverté, John Wiley & Sons, 2003.
- Askeland D.R., “Ciencia e Ingeniería de Materiales”, . Editorial Thomson, 2001.
- Brostow W., “Introducción a la Ciencia de los Materiales”.
- Bedford A., Liechti K. “Mecánica de materiales”,Prentice Hall 2002.
- Smith W. F., “Fundamentos de la Ciencia e Ingeniería de los Materiales”, Mc Graw Hill, 1996.