NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF CHEMICAL AND TEXTILE ENGINEERING
CHEMICAL ENGINEERING PROGRAM

PI513 – INDUSTRIAL MATERIALS

I. GENERAL INFORMATION

CODE	**:**	PI513 Industrial Materials
SEMESTER	**:**	7
CREDITS	**:**	2
HOURS PER WEEK	**:**	3 (Theory – Practice – Labs)
PREREQUISITES	**:**	QU526 Quantitative Chemical Analysis
CONDITION	**:**	Compulsory

II. COURSE DESCRIPTION

This course trains students in the application of basic principles of science and technology of materials in engineering, with emphasis in the criteria for their elaboration and behavior in service based on their class, properties and applications. Ferrous and non-ferrous alloys are classified and studied, and non-metallic materials derived from the processing of natural raw materials and artificial and synthetic materials. In all cases, problems based on the integration of previous knowledge of physics, chemistry, mathematics and graphic expression are solved, using, specialized software and descriptive and analytical methods.

III. COURSE OUTCOMES

1. Apply fundamental concepts and criteria for an adequate selection of materials for a certain use, based on the knowledge of its physical, chemical and technological properties, and considering the environment and the conditions in which it will be exposed during its behavior in service.
2. Recognize, recommend and participate in the implementation of different types of techniques of conformation for engineering materials.
3. Apply fundamental knowledge of simulation of the future behavior of new materials, applying quantitative methods and laws ruling the theory of manufacturing metallic and non-metallic materials, applying the related knowledge, programming software.
4. Adequately communicate the results of the assessment of possible materials to be used, to be employed in the decision making if an industrial plant.

IV. LEARNING UNITS

1. FUNDAMENTALS OF MATERIALS ENGINNERING AND SCIENCE / 20 HOURS

Raw material and materials / Materials classification / Physical, chemical and technological properties / Auxiliary materials / Fundamentals of the procurement of iron and steel / General studies of flow charts / The solid state. Crystal structures / Typos of unit cells and metal crystal lattices / Principles of physical metallurgy / Principles of the processes of materials conformation in the industry / Principles of conformation by plastic deformation in cold and hot. Forge, lamination, embossing, drawing, etc. / Fundamentals about shear conformation with blowpipe and welded joint, dust metallurgy, machining and casting / Contractions of metals and alloys.

2. FUNDAMENTALS ABOUT MATERIAL TESTINGS / 10 HOURS

Fundamentals about mechanical tests on materials. Materials hardness, tension, flexion and compaction. Standard tests. Stress- strain curves. Problems / Elasticity of materials. Elasticity module and its application. Tests of metallic materials fatigue and impact. Standardization. Problems / Non-destructive material test / Tests with penetrating liquids, video tape recording, industrial radiography and ultrasound. NDT and industrial quality.

3. STUDY OF FERROUS AND BINARY ALLOYS / 20 HOURS

Fusion and solidification of a pure metal and metal alloys. Curves / Ways in which stages of alloys are presented: Solid solution, free element and inter-metallic compound / Diagrams of stages of binary metal alloys. Fundamental laws. Equilibrium diagrams of typical phases. Deduction of the lever law /

Phase transformations in binary alloys: eutectics transformation, eutectoid transformation and peritectic transformation. Problems and analysis of solidification.

4. FERROUS ALLOYS / 10 HOURS

Ferrous alloys. Classification / Cast iron and common or carbon steel, cast iron and special steels, iron-carbon diagrams / Cast iron and steel structures / Influence of the different alloy element on cast iron and common and special steel / Problems about alloy laws applied to ferrous alloys, solidification analysis and determination of micro-structures / Elaboration of standard ferrous alloys. Melting furnace and load calculation / Problems about load calculation and cast iron and steel standardization / Solution to problems about elaboration of ferrous alloys.

5. NON-FERROUS ALLOYS / 15 HOURS

Non-ferrous alloys. Classification of non-ferrous metals and their alloys. Standardization and name (Nomenclature) / Fusion and forge alloys / Copper alloys / Bronze and common and special brass / Load calculation for their elaboration / Light alloys. Aluminum. Properties and applications / Aluminum alloys. Classification, properties and applications / Aluminum-copper alloys. Classification, properties and applications. Special study of duralumin.

Ultralight alloys. Magnesium and its alloys / Physical, chemical and technological properties of pure magnesium. Uses / Alloys of magnesium. Classification, properties and applications. Standardization / Other alloys of non-ferrous metals / Titanium and its alloys.

6. CERAMIC MATERIALS / 8 HOURS

Concept, classification, procurement, uses, properties and applications / Ceramics derived from clay. Elaboration, classification, properties and applications / determination of properties of ceramic materials. Apparent and real porosity, apparent and real density, mechanical resistance and durability / Total porosity – mechanical resistance ratio. Problems / Special ceramics. Glasses, carbides, cement and refractory materials / Refractory materials. Concept, classification, elaboration, properties and applications / Silica-alumina diagram and other equilibrium diagrams for the study of refractory systems.

7. POLYMERIC MATERIALS / 8 HOURS

Fundamentals, concepts and origin of polymers / Importance in modern life / Thermoplastic and thermostable polymers / Mechanism of formation of a polymer / Degree of polymerization / Distribution of molecular weight / properties and applications / Problems.

8. COMPOUND MATERIALS / 8 HOURS

Compound materials (Composites) / Concept. Types of joint, classification, properties and application of compound materials / Compound hardened by fine particles dispersion, compound reinforced by real particles, cemented carbides, electrical contacts, special molds and conductors in synthetic sand for cast and other compound materials / Compounds reinforced by fibers / Special composites. Polymers and their compound materials.

V. LABORATORIES AND PRACTICAL EXPERIENCES

Lab 1: Determination of crystal structures of metals.
Lab 2: Methods of conformation and mechanical tests.
Lab 3: Microstructure of ferrous and non-ferrous materials.
Lab 4: Determination of properties of ceramic materials.

VI. METHODOLOGY

The course is carried out in theory, practical and lab sessions. In theory sessions, the instructor introduces concepts, theoretical deduction and applications. In practical sessions, several problems are solved and their solutions are analyzed. In lab sessions, the available equipment and material is used, complementing with videos and prototypes that students elaborate in group works. At the end of the course, students must hand in and expose a paper or an integrating project. In all sessions, students' active participation is encouraged.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

$$PF = 0.25\,EP + 0.25\,EF + 0.25\,[(P1 + P2 + P3 + P4)]/4 + 0.25\,[(L1 + L2 + L3)]/3$$

EP: Mid-Term Exam EF: Final Exam P#: Quizzes L#: Labs

VIII. BIBLIOGRAPHY

1. **ZBIEGNIEW D. JASTRZEBSKI**
   Material Engineering (Spanish)
2. **DONALD ASKELAND**
   Materials Science and Engineering (Spanish)