NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF INDUSTRIAL AND SYSTEMS ENGINEERING

INDUSTRIAL ENGINEERING PROGRAM

SYLLABUS - TP303 MATERIALS ENGINEERING

I. GENERAL INFORMATION

CODE	:	TP303
SEMESTER	:	6
CREDITS	:	3
HOURS PER WEEK	:	4 (Theory – Practice – Labs)
PREREQUISITES	:	TP213 Physical Chemistry and Unit Operations
CONDITION	:	Compulsory
INSTRUCTOR	:	Guillermo Cruz, Rolando Aguero

II. COURSE DESCRIPTION

This course trains students in the application of basic principles of science and technology of manufacturing 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, as well, specialized software and descriptive and analytical methods.

III. COURSE OUTCOMES

1. Apply fundamental concepts and criteria for an adequate selection of a material 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 and simulation language according to the progress.
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. Network parameters and packing factors. Calculations / 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. Determination of contractions during cooling in liquid state, during solidification in solid state. Way of compensating contractions and their relationships with the defectology derived from cooling and solidification. Problems about contractions / Notions about cast design in cast parts. Existent software / Presentation of cases of parts to be conformed by casting. Draw in casting and study of cases of mold elaboration and views in different sections of prepared molds.

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.

5. ELABORATION OF FERROUS ALLOYS / 10 HOURS

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.

6. 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. Uses, properties and applications / Special alloys of non-ferrous metals. Study cases.

7. 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. Lever law. Calculation and problems.

8. 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 polymeration / Distribution of molecular weight / properties and applications / Problems.

9. 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 / Classification according fiber type and disposition. Special composites. Polymers and their compound materials.

10. NUCLEAR AND RELATED MATERIALS / 8 HOURS

Fundamentals of nuclear physics and nuclear materials / Interaction of radiation-matter. Uranium and nuclear reactors / Radioactive material, production of radionuclide and applications. Safety aspects / Industrial, environmental, energetic, hydrologic and mining applications of nuclear technology / Fundamentals of irradiation technology. Industrial applications / Power station for the generation of nuclear energy.

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.
Lab 5: Demonstration of properties of isotopes and ionizing radiations.

VI. METHODOLOGY

The methodology applied in this course consists of the technique exposition-dialog of the central topic of the class with audiovisual aids and multimedia equipment, intensively using all the chances given by the virtual campus. 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 Enginnering (Spanish)
3. **ALBERT GUY**
   Fundamentals of Materials Science (Spanish)
4. **LAWRENCE E. DOYLE**
   Materials and Manufacture Process For Enginnering