NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF GEOLOGICAL, MINING AND METALLURGICAL ENGINEERING

METALLURGICAL ENGINEERING PROGRAM

ME524 – MATERIALS STRUCTURE AND PROPERTIES

I. GENERAL INFORMATION

CODE	**:**	ME524 Materials Structure and Properties
SEMESTER	**:**	9
CREDITS	**:**	4
HOURS PER WEEK	**:**	6 (Theory–Practice–Laboratory)
PREREQUISITES	**:**	ME429 Physical Metallurgy
CONDITION	**:**	Compulsory
DEPARTMENT	**:**	Metallurgical Engineering

II. COURSE DESCRIPTION

The course prepares students in the identification and use of the properties of materials. Structural details are defined in the proper scale to explain the properties of materials, as well as understand the mechanisms that govern their structural transformations. Students analyze different technological processes developed for improving the properties of materials considering the transformation theories to solid state, taking into account safety, hygiene and environmental norms and standards.

III. COURSE OUTCOMES

At the end of the course, students:

1. Identify, recognize, measure and apply the mechanical properties of materials.
2. Define and describe the structure of solid materials.
3. Relate materials properties with their structures.
4. Explain materials structural changes and analyze their causes.
5. Apply structural transformations in thermo-mechanical technological processes, fulfilling safety and environmental regulations.

IV. LEARNING UNITS

1. DEFINITION OF MATERIALS PROPERTIES AND STRUCTURES

Properties definition / Materials classification / Spot, lineal and surface crystalline defects / Sliding / Macle / Piling failure / Surface / Crystalline defects impact on material properties.

2. EQUILLIBRIUM INTERPHASES. DEFORMED STRUCTURES

Phases in condensed structures / Thermodynamic and structural aspects of interphases / Plastic deformation effects on interphases configuration.

3. CLASSIFICATION OF SOLID STATE TRANSFORMATIONS

Diffusion / Dislocations slides / Macle / Invariant composition transformations / Recrystallization / Polymorphism / Massive transformation.

4. TRANSFORMATIONS BY DIFFUSION WITH COMPOSITION CHANGES

Spinodal transformation / Short and long scope transformations / Continuous precipitation / Discontinuous precipitation / Effects on material properties.

5. THERMO-MECHANICALLY ACTIVETED TRANSFORMATIONS

Shearing transformations / Martensitic transformations / Bainite transformation / Effects on material properties / Hardenability / Tempering / Hardenability and tempering evaluation methods.

6. APPLICATIONS OF TECHNOLOGICAL TRANSFORMATIONS

Heating treatments / Thermo-mechanical treatments / Thermo-chemical treatments / Hardening by film: Cathodic pulverization / Furnaces, equipment and environment.

V. LABORATORY

Session 1: Recrystallization. (Research project)
Session 2: Jominy Test.
Session 3: Sputtering hardening.
Session 4: Carbone-nitriding treatment.

VI. METHODOLOGY

The course takes place in theory, practice and laboratory sessions. In theory, faculty presents and analyze concepts and methods. In practice sessions diverse problems related to technological transformations of materials properties are analyzed and solved. In laboratory sessions, students perform experimental tests and verify expected outcomes and results. After each laboratory experience, students submit a report describing procedures and summarizing results and conclusions. Students visit an industrial plant to analyze technological transformation processes and material properties. Student's active participation is promoted.

VII. GRADING FORMULA

The Final Grade PF is calculated as follow:

PF = (EP + EF + PP) / 3

EP: Mid-term Exam EF: Final Exam
PP: Average of Practical and Laboratory Works.

VIII. BIBLIOGRAPHY

1. D. A. Porter, K.E. Easterling, M. Y. Sherif.
   Phase Transformations in Metals and Alloys. CRC Press Taylor & Francis Group, 3rd Ed. 2009.
2. Robert W, CHN, Peter HAASEN.
   Physical Metallurgy, Elsevier Science, 2002.