INSTITUTO DE FÍSICA
FACULTAD DE FÍSICA

COURSE	:	**TOPICS IN MATERIAL SCIENCE**
TRANSLATION	:	TÓPICOS EN CIENCIA DE MATERIALES
NUMBER	:	FIM3006
CREDITS	:	15 UC / 9 SCT
MODULES	:	3
REQUISITES	:	FIZ0321 Y FIZ0322
CONECTOR	:	AND
RESTRICTIONS	:	030401, 030501
CHARACTER	:	OPTATIVE
FORMAT	:	THEORETICAL LECTURES (2) AND LABORATORY (1)
FORMATIVE LEVEL	:	MAGISTER
QUALIFICATION	:	STANDARD
DISCIPLINE	:	PHYSICS

I. COURSE DESCRIPTION

This course addresses some topics about materials regarding their crystalline structure, types of defects, and how these characteristics affect their mechanical behavior. The effects of thermally induced microstructure changes such as annealing and recrystallization on the volumetric properties of the solid are also studied. The basic characterization techniques are reviewed to obtain chemical, morphological and structural information of the materials. Finally, the course addresses topics related to nanomaterials and advanced materials of technological interest. On the other hand, the course also includes some laboratories where students learn vacuum techniques for the growth of a nanomaterial and all the instrumentation associated with the technique. The practical part also involves demonstration sessions on characterization techniques available in the Materials Science laboratory.

II. LEARNING OUTCOMES

General learning objective:

- Acquire basic and practical knowledge in Materials Science topics aimed at
- Motivating interest in theoretical as well as experimental study in materials physics with technological applications.

Specific learning objectives:

1. Identify the characteristics of the different crystal structures, recognizing coordination numbers, planes and crystallographic directions within the solid.
2. Classify the different types of defects or imperfections existing in a solid, understanding their main effects on the crystal lattice.
3. Explain the mechanisms of elastic and plastic deformation in a solid, correlating them with its crystalline structure and the presence of defects.
4. Identify the relationships between microstructure and properties, including annealing and recrystallization heat treatments.
5. Understand the basic characterization techniques for obtaining chemical, morphological and structural information on materials.
6. Distinguish the basic characteristics and properties of a nanomaterial with respect to its volumetric shape.
7. Discuss the properties of advanced materials and their technological applications.

III. CONTENT

1. Classification of materials: amorphous, crystalline, single crystals and polycrystals.
2. Crystal structure: crystallographic planes and directions, compact arrangements.
3. Types of defects or imperfections in solids: point, linear, surface and volumetric.
- Thermodynamics of the equilibrium vacancy concentration.
4. Mechanical behavior of materials: elastic and plastic deformation
- Atomic bases of Young's modulus and Morse potential.
- Mechanisms of plastic deformation: dislocations.
- Sliding systems, resolved critical shear stress.
5. Heat treatments and microstructural control
- Annealing or annealing (polygonization) and recrystallization: nucleation and grain growth
- Phase transformations
6. Materials characterization techniques
- Techniques for the acquisition of chemical (EDS), morphological (AFM, SEM) information, and structural (XRD, RAMAN)
7. Materials of technological interest
- Preparation methods, characteristics and properties of nanomaterials
- Thin films and growth mechanisms (lattice mismatch)
- Properties of advanced materials and applications.

IV. METHODOLOGICAL STRATEGIES

- Lectures on the course contents,
- Practical work and
- Demonstration sessions in research

V. EVALUATIVE STRATEGIES

- laboratory activities (25%),
- student presentations (10%),
- tests (50%),
- evaluations obtained from the practical laboratory sessions (15 %).

VI. BIBLIOGRAPHY

REQUIRED

1. Donald R. Askeland and Pradeep P. Phulé, *The Science and Engineering of Materials*, 4th ed, Thomson-Engineering (2002).

2. William Callister, *Materials Science and Engineering: an introduction*, 7th edition, Wiley (2007).

OPTIONAL

1. A.S. Edelstein and R.C. Cammarata, *Nanomaterials: synthesis, properties and applications*, Institute of Physics Publishing Bristol and Philadelphia (1998).

2. Guozhong Cao, *Nanostructures and Nanomateriales: synthesis, properties and applications*, Imperial College Press (2004).