INSTITUTO DE FÍSICA
FACULTAD DE FÍSICA

COURSE	:	**TOPOLOGY IN MANY PARTICLE SYSTEMS**
TRANSLATION	:	TOPOLOGIA EN SISTEMAS DE MUCHOS CUERPOS
NUMBER	:	FIM4005
CREDITS	:	15 UC / 9 SCT
MODULES	:	2
REQUISITES	:	FIZ0411
CONECTOR	:	AND
RESTRICTION	:	030401, 030501
CHARACTER	:	OPTATIVE
FORMAT	:	THEORETICAL LECTURES
FORMATIVE LEVEL	:	DOCTORATE
DISCIPLINE	:	PHYSICS AND ASTRONOMY

I. COURSE DESCRIPTION

This course is an introduction to theoretical models used in describing experimental phenomena in the areas of quantum optics and condensed matter. Special emphasis is made in topological properties and effects in physical systems. The course introduces to the basic mathematical and topological concepts as well as to the basic tools of quantum optics and condensed matter.

II. LEARNING OUTCOMES

1. Familiarize the student with advanced mathematical tools for the description and analysis of topological effects in physical systems.
2. Introduce the student to topological effects and properties observed in experiments.

III. CONTENT

1. Physical Motivation
    a. A simple example: Berry Phase in two-level system

2. Introduction to Geometry and Topology
    a. Mathematical concepts
        i. Manifolds and vector fields
        ii. Tensors and exterior forms
        iii. Integration on differential forms
        iv. Covariant differentiation and curvature

    b. Topological concepts
        i. Holonomy, Kronecker index
        ii. Gauss-Bonnet theorem
        iii. Vector bundles in geometry and physics
        iv. Fiber bundles and topological quantization

3. Topology in many body particles
    a. Physical examples
    b. Aharonov-Bohm effect and Berry phase
    c. Hall effect
    d. Spin Hall effect

e. Topological Insulator
f. Topological Faraday Rotation and more.

IV. METHODOLOGICAL STRATEGIES

- Two classes per week.
- Homeworks.
- Reading of literature.

V. EVALUATIVE STRATEGIES

- Homeworks (70%)
- Final Oral Presentation (30%)

IV. BIBLLIOGRAPHY

REQUIRED

- Frankel, T *The Geometry of Physics*, Cambridge (2004).
- Nakahara, M *Geometry, topology and physics*, Taylor and Francis (2003).
- Nash, C y Sen, S *Topology and geometry for physicists*, Academic Press Inc. (1983).
- Ashcroft, N W and Mermin, N D *Solid State Physics*, World Publishing Corp. (2004).
- Altland, A y Simons, B D *Condensed matter field theory*, Cambridge University Press (2010).
- Scully, M O and Zubairy, M S *Quantum Optics*, Cambridge Unversity Press (1997).
- Ezawa, Z F *Quantum Hall Effects*, World Scientific (2008).

OPTIONAL
N/A