PEM5137 – 2 Type: POSTGRAD

Name: Introduction to Magnetism and Magnetic Materials

Main area: Applied Superconductivity (97135)

Dates of acceptation:

CCP: 19/09/2012

CPG: 07/11/2012

CoPGr:

Activation date: 08/11/2012

Desactivation date:

Course load: 180 h

Total: 180 h Theoretical: 4 h Practical: 4 h Study: 4 h

Credit: 12 Duration: 15 weeks

**Objectives**

To introduce basic concepts of magnetism to deeper understanding of magnetic properties of materials that exhibit magnetic ordering.

**Justification:**

To go deeper on some important concepts of magnetism and magnetic materials in order that students that work on obtaining and characterizing ferromagnetic, ferrimagnetic and antiferromagnetic materials can be capable to understand and relate the microstructure and magnetic properties of materials. These concepts will be introduced mainly by using phenomenological theories, but also some particularly important quantum concepts will be addressed.

**Contents**

1. Introduction 1.1 Related observations to magnetic fields 1.2 Magnetism and currents1.3 Types of Magnetism 1.4 Magnetic materials for applications; 2. Magnetostatic, 2.1 Boundary Conditions for B and H, 2.2 Field and factor of demagnetization, 2.3 Magnetization curves, 2.4 Magnetostatic and Thermodynamic Energy; 3. Classical and quantum phenomenology of the magnetism, 3.1 Orbital and Spin magnetic moments, 3.2 Classical diamagnetism, 3.3 Classical paramagnetism, 3.4 Quantum paramagnetism and diamagnetism, 3.5 Ferromagnetism; 4. Quantum mechanics and magnetism, 4.1 Dipolar interaction, 4.2 Exchange interaction, 4.3 Molecular field theory, 4.4 Super-exchange, 4.5 Dependence of the temperature on ferrimagnetism, 4.6 Metals, 4.7 Kondo effect, 4.8 Transitions in quantum phases - Heavy Fermions; 5 Magnetic Anisotropy, 5.1 Phenomenology, 5.2 Physical origin, 5.3 Dependence with temperature; 6. Magnetoelastic effects, 6.1 Phenomenology, 6.2 Magnetoelastic contribution to the anisotropy, 6.3 Magnetostriction, 6.4 Δ E effect and inverse magnetoelastic effects, 6.5 Temperature dependence; 7. Magnetic domains, 7.1 Magnetic configurations – the compromise, 7.2 Domain walls; 8. Types of magnetic materials, 8.1 Soft, 8.2 Hard.

**Bibliography:**

1) Robert C. O´Handley Modern Magnetic Materials: Principles and Applications, John Wiley and Sons, 2000. 2) Soshin Chikazumi, Physics of Magnetism, John Wiley and Sons Inc. NY, 1964. 3) Richard M. Bozorth, Ferromagnetism, IEEE Press, 1993. 4) S. Blundell, Magnetism in Condensed Matter, Oxford University Press, 2001. 5) É. Du Trémolet de Lacheisserie, D. Gignoux, M. Schlenker, Magnetism Fundamentals, Springer, 2005.

**Remark:**

The evaluation of the course will be through application of two tests or a test and an individual homework.