Curso de Doctorado
Doctorado en Ingeniería Matemática—UCM
Doctorado en Investigación Matemática—UCM
Mención hacia la excelencia MEE2011-0021

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Numerical Simulation and Optimization of Industrial Problems

Abstract

These lectures are devoted to show some applications of mathematical modelling and optimization to industrial problems.

Three problems related to different fields of physics will be considered. The first two problems concern electromagnetism and heat transfer so a general overview of these subjects will be given in the first lecture. In particular, mathematical models and methods for eddy current problems will be recalled.

The second lecture deals with induction furnaces for the metallurgical industry. It will include the description of the industrial problem, its mathematical modeling and its numerical solution by finite element methods.

The third lecture concerns numerical simulation applied to electrical motor design. We will consider both the electromagnetic and thermal modeling. For the latter we will use the so called Galerkin Lumped Parameter (GLP) models as an economical alternative to the classical finite element methodology.

The last two lectures will be devoted to the application of mathematical methods to optimize a gas transport network. We first recall the fluid mechanics equations for viscous compressible flows and then some simplifications will be made in order to obtain a tractable model. Existence of solution to this simplified model and its numerical solution will be addressed. Next, we will consider the optimization of the gas network operation in terms of the energy consumed for compressing the gas to compensate the head losses due to viscous friction. Optimal control techniques and mathematical programming algorithms will be introduced. Applications to real gas transport networks will be shown.

Lecture 1. Mathematical modeling in electromagnetism

Lecture 2. Numerical simulation of induction furnaces for silicon metallurgy

Lecture 3. Electromagnetic and thermal analysis of electric motors

Lecture 4. Mathematical models for gas transport networks

Lecture 5. Optimization of gas networks

Organizado por el Proyecto Europeo FIRST y el Instituto de Matemática Interdisciplinar (IMI)

Del 21 al 25 de octubre de 2013

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