Laboratoire de Conception et d'Intégration des Systèmes

PhD Defense

Friday, 13 February 2026 at 14:00 in A042

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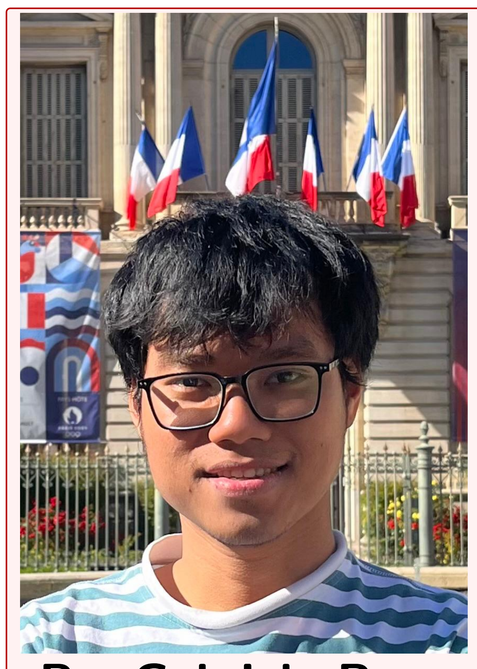

Minh Tuan DINH will defend his thesis titled

Advanced Control for a Three-Phase Electric Arc Furnace Producing Silico-Manganese

in front of the jury members

Pr. Gabriele Pannocchia	**University of Pisa, Italy**	**Reviewer**
Pr. Vicenc Puig	**Universitat Politècnica de Catalunya, Spain**	**Reviewer**
Pr. Alexandra Grancharova	**Univ. of Chemical Technology and Metallurgy, Bulgaria**	**Examiner**
Pr. John J. Martinez-Molina	**Gipsa-lab, Grenoble INP, UGA, France**	**Examiner**
Dr. Alexandre Chenu	**Eramet Ideas, France**	**Invitee**
Jonathan Lamboley	**Eramet Ideas, France**	**Invitee**
Dr. Dina Irofti	**EDF, France**	**Invitee**
Olivier Lesage	**Eramet Ideas, France**	**Co-supervisor**
Pr. Eduardo Mendes	**LCIS, Grenoble INP, UGA, France**	**Co-director**
Dr. Ionela Prodan	**LCIS, Grenoble INP, UGA, France**	**Director**

Abstract: Electric arc furnace (EAF) is widely used in the steel industry for melting and refining steel or alloy products, particularly manganese (Mn) ferroalloys, essential and irreplaceable ingredients in carbon steel production. In recent years, EAF technologies have shown steady growth in production capacity and global market share, driven by increasing demand for highly energy-efficient methods and the need for more environmentally friendly production. This has become especially important in the context of France's ambition to achieve the 2050 Carbon Neutrality Plan.

Mn ferroalloys are made by melting and reducing manganese ores, coke and fluxes in an EAF. This furnace relies on the Joule effect from a three-phase alternating current, transmitted through three electrodes, to provide the thermal energy for melting and reduction reactions. Electrical regulation, which directly controls energy use, is critical to furnace operation because it operates and reacts on short timescales, unlike most other process levers and indicators, such as input/output materials or temperatures.

This thesis aims to develop a scalable and flexible control framework for a three-phase EAF producing Silico-Manganese capable of handling the complex system interconnections, explicitly incorporates operational constraints and improves electrical system stability and productivity. To this end, electrical principles such as Kirchhoff's laws and Ohm's law are used to model the system's electrical behavior accurately. Moreover, well-established concepts such as MPC (Model Predictive Control) and MIP (Mixed-Integer Programming) are adapted and integrated into the optimization-based control design, ensuring effective and flexible strategic regulation of furnace operation. In addition, the design of computationally efficient solving algorithms using heuristic approaches is considered to address the computational demands of the MIP problem in real-time implementation. The control frameworks are validated through numerical simulations on the real-time SIL (Softaware-in-the-loop) simulator. Finally, we lay the groundwork for future research and further enhancements, while providing concrete steps toward the implementation of real model predictive control experiments.

Keywords: Electric Arc Furnace, Submerged Arc Furnace, Electrical System, Model Predictive Control, Mixed-Integer Programming, Heuristic Rounding, Bilevel Optimization, Software-in-the-Loop Simulation.