The successful candidate will carry out his research in IRTES-M3M laboratory, INCIS team. He (or she) will be supervised by:

**Mr Abboudi Said** Professor
And
**Mr Lebal Nadhir**, Associate Professor

**Title:** Optimization of the material process and product interaction: application to injection molding

**Abstract:**
Multi-physics simulation is necessary to model real-world situations, explore design options, and guide R&D. Injection process involves many technical disciplines (fluid, heat transfer, material, solidification, polymer,...) and many computational codes such as: Rem3D®, Fluent®, Abaqus®, Ansys®.

Injection molding is the most commonly used polymer processing operation for the fabrication of plastic parts. The injection process allows the manufacture of great range of products which vary in their size, complexity, and application, at high production rates and with a large degree of automation, in a single operation.

An injection machine is basically composed of two mains parts: - an injection molding machine, where polymer is molten in a screw - barrel system after having be introduced in the granule form through a hopper, and a mold.

Injection molding processing involves then the non-isothermal flow of a viscous molten polymer, a solidification phase, the flow of a semi solid material during solidification and stress relaxation in the solid. In any case, thermomechanical models have to be developed that should account for specificity of properties of polymers. In particular, the viscoelastic behavior of both the molten and the solid material should be accounted for.

To guarantee the quality of the final parts, a precise characterization and monitoring of the injection molding process is essential. Using analytical solutions is limited due to the complexities of the governing equations, of the material behavior and of the cavity geometry. Therefore, numerical tools are a good solution to get useful results. To achieve such code governing equations are solved by the computational algorithms in a discretized form. In the literature, a variety of numerical methods were developed such as the finite element method, the finite difference method, the meshless particle method, and the boundary element method. Each method has some advantages in a certain class of problems.

**Objectives of the proposed subject:**
- Identification and development of methodologies of optimization, allowing to overcome difficulties linked to the proposed problems.
- Definition of the objectives functions, and constraints, intended to be used for the problem formulation assuring a mathematical quantification of defects and objectives.

- Coupling the optimization methodology adopted as well as quality criteria with the developed or commercial codes (Rem3D ® and Abaqus®, Ansys®) in order to study the polymers flows in tools during injection process.

**Keywords:** Numerical simulation, finite element, optimisation, interaction material-product-process, injection molding, polymer, rheology.

**Required competences:**
- Mechanical-Material-Process
- Non-linear mechanic
- Rheology: polymer flow, injection molding
- Numerical methods, commercial codes (Abaqus, Ansys, Rem3D…).
- Optimization (Conjugate gradient, Newton, Stochastic, hybrid methods).

**References**


The IRTES consists of:
- 314 members including 136 PhD students
- 14,000 m² allocated to offices and technology platforms.
- 5 million euros of budget per year.

IRTES-M3M: Mechatronics Laboratory: Methods, Models and Crafts, is one of the four laboratories of IRTES Institute. It has about 60 members including 18 PhD students, over three teams:
- MOS Team: Modeling and Structural Optimization
- INCIS Team: Digital Engineering for the Design of Mechanical Systems
- SMA Team: Mechanical Adaptive System

The Research budget, about 1.5 M€ over the last four years, comes from Local authority (37%), Ministerial fund for competitiveness (32%), European funds for regional development (13%), Industrial contracts (13%), Ministry of research (5%) and European projects (1%).
Simplified Curriculum Vitae

ABBOUDI Said

Professor

University of Technology of Belfort Montbéliard
Université de Technologie de Belfort Montbéliard (UTBM)

IRTES-M3M: Mechatronics Laboratory: Methods, Models and Crafts
IRTES-M3M : Laboratoire de Mécatronique : Méthodes, Modèles et Métiers (M3M)

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Education

First Ph.D. (Doctorat de 3ème Cycle), Heliophysics laboratory, University of Aix-Marseille, 1982.

Thesis subject: Transient conjugated forced convection in rectangular channel under variable boundary conditions, application to solar system.

Experience

- Full Professor, UTBM, October 2011
- Associated Professor, UTBM, 1988-2011.
- Associated Professor, Department of Physics, University of Aix-Marseille 1, 1981-1984 and 1987-88.
- Associated Professor, Department of Applied Physics, University of Corse, 1985-86.
- Teaching Assistant, University of Aix-Marseille 3, Department of Sciences and Technics, 1980-81.

Research activities

Key words: Conduction, convection, multimaterial, conjugate heat transfer, thermal coupling, numerical methods, optimization, inverse problems, multi-physics coupling.

Scientific production

- International journals: 60 papers
- Plenary lecture : 3
- National journals: 7 papers
- International conferences: 160 papers
- National conferences: 40 papers
- Other conferences: 5 papers
Supervisor

- Masters: 14 students
- Thesis: 18 students
- Thesis in progress: 4

Reviewer for journals and conferences

- Applied Thermal of Engineering
- Journal of Heat Transfer
- Numerical Heat Transfer
- Thermal Stresses
- Inverse Problem of Science Engineering
- Int. Journal of Thermal Sciences
- Acta Mechanica
- Physical Sciences Research International
- Heat Mass Transfer
- Journal of Renewable and Sustainable Energy
- Thermal Sciences, an International Journal
- Journal of Engineering Science and Technology
- Asian Heat Transfer Journal

- 26th International Thermal Conductivity Conference, 14th International Thermal Expansion Symposium, ITCC26, ITES14, 6-8 August 2001, Cambridge, Massachusetts, Boston.
- Congrès Français de Mécanique, Besançon, aout 2011.
- Congrès National de Mécanique des Fluides, Alger, octobre 2012.
- Journées Internationales de Thermique JITH’13, Marrakech, novembre 2013.
- Journées des Jeunes chercheurs de l’UTBM, INGEDOC
- International Conference on Renewable Energy: Generation and Applications” ICREGA’16, 8-10 février, Belfort.

Industrial and Scientific collaborations

- EDF Les Renardières - Moret sur Loing: 1996
- FRANHOFER Institute IPM Heidenhofstrafle 8, Fribourg: 1996-97
- Peugeot Belchamp, Montbéliard: 1998
- VonRoll, Delle: 2012.

International collaborations

University of Beyrouth, Lebanon: 5 masters, 2 theses
University of Tlemcen, Algeria: 1 thesis, 2 theses in progress
University of Constantine, Algeria: 1 thesis, 2 theses in progress
University USTHB, Alger, Algeria: 2 theses in progress
University of Batna, Algeria: 2 theses.
University of Kénitra, Morocco, 1 thesis in progress
University of Marrakech, Morocco, in progress
UTSEUS University of Shanghai, China, in progress
Educational activities

Educational activities at UTBM: course 30 hours, tutorial works 28h, practical works 14h

- Mathematics for engineer, since 1989
- Numerical methods for engineer, since 1989
- Heat transfer, since 1990
- Advance and applied mathematics for engineer, since 2009
- Probabilities and statistics: course (20h) conducted at the University of Shanghai, 200

Educational activities: before 1988

- Optic, University of Aix-Marseille 1, 1981-82
- Electrostatic, magnetostatic, University of Aix-Marseille 1, 1983-84
- Electromagnetism, relativistic mechanics, University of Aix-Marseille 1, 1982-83
- Electrical circuit, Energetic, University of Corse, 1985-86.

Educational activities for Masters

- Heat and mass transfer: 12 h, Belfort, Université de Franche Comté, 1990-92.
- System analysis and optimization: 30h, University of Constantine, 1989-91.
- Optimization and inverse methods in thermal systems: 25h/an, University of Liban, Beyrouth, 2003-2016.

Educational activities for industrials

- Solid mechanic: 24h/year, UTBM, 1990-1994
- Heat exchangers: 30h, Peugeot (Sochaux), 2002-03.
- Thermodynamic: 20h/year, UTBM, 2001-2004
- Heat conduction in composite material: 30h, Von Roll, 2013

Administrative responsibilities

- Selection Committee, UTBM, 2011-2012.
- Council of IRTES Institute, UTBM, since September 2012
- Academic Council of Comue, UBFC, 2016