جامعة عبد المالك السعدي
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Université Abdelmalek Essaadi

Pole for Doctoral Studies
Center for Doctoral Studies
Sciences, Technologies, and Medical Sciences

ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE

Ms. MOUTAHIR Fatima-Ezzahrae

Will present here research work with the aim of earning a Doctorate

Doctoral program: Engineering Sciences and Techniques (STI)
Discipline: Mathematics
Specialty: Applied Mathematics

On 29/07/2025 at 10H30 at the Conference Hall, F Building, Faculty of Sciences and Techniques of Tangier, UAE
Under the Theme

Phase Change Problems: Mathematical Modeling and Simulation

Front of the jury composed of :

First Name & Last Name	Establishment	Designation
Pr. EL JARROUDI Mustapha	FST of Tangier, UAE	President
Pr. EL MOCAYD Nabil	Mohammed VI Polytechnic University of Ben Guerir	Reviewer
Pr. YAKOUBI Driss	Leonard de Vinci University Center, France	Reviewer
Pr. EL KACIMI Abdellah	FP of Safi, UCA	Reviewer
Pr. LAHROUZ Adil	FST of Tangier, UAE	Examiner
Pr. ADDAM Mohamed	ENSA of Al Hoceima, UAE	Examiner
Pr. BELHAMADIA Youssef	AU, Sharjah United Arab Emirates	Co-Supervisor
Pr. EL ANJOUMI EL AMRANI Mofdi	FST of Tangier, UAE	Supervisor

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Abstract

Phase change problems are of considerable importance in many technical applications and natural processes such as the evolution of ice floes, food freezing, biocryogenics, molding, continuous casting, crystal growth, nuclear reactor safety, thermal control of spacecraft, and thermal storage. A phase change in a material refers to the transition between different states of matter, such as from the liquid state to the solid state. Since our applications involve high temperatures, radiation cannot be neglected.

Coupling phase change problem with radiative transfer is complex and their experimental investigations can be extremely difficult to carry out and very demanding to achieve. In this thesis, we develop mathematical models and accurate numerical methods for studying and simulating such coupled phase change with radiative transfer in non-grey absorbing and emitting media. Progress in this area of mathematical modelling would contribute to a sustainable future manufacturing involving high temperature and phase change. Accurately predicting the phase-change interface is the crucial step for these applications in non-grey semi-transparent media. First, we present the conduction and radiation effects that are analyzed by a set of nonlinear partial differential equations and a linear integral equation, respectively.

The proposed model forms a system of nonlinear integro-differential equations and it accounts for both thermal radiation and phase change. For non-grey media, the spectrum is divided into a sequence of finite intervals of frequency bands with averaged absorption coefficients resulting in coupled systems to be solved for each frequency band. The coupled equations are approximated using a second-order method in both time and space. Using discrete ordinates for the angular discretization of the integral equation for the radiation effects, a Newton-type algorithm is used to deal with the nonlinear systems. Next, we propose a simplified model for thermal radiation to be included in the phase-change equations. The proposed formulation leads to a system of coupled nonlinear partial differential equations.

As numerical solver we implement a fully implicit time integration scheme and a Newton-type algorithm is used to deal with the nonlinear terms. Then, several numerical examples are considered to illustrate the accuracy of the proposed approach. Finally, we present applications involving nanofluids and composite materials.

Keywords: Phase change problems, Radiative heat transfer, Discrete ordinates, Finite difference method, Newton method, Nanofluids, Composite materials.