



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

## ANNOUNCEMENT OF DOCTORAL THESIS DEFENSE



**Ms. BEKKAY HAOUARI Khadija**

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

**Doctoral program: Engineering Sciences and Techniques**  
**Discipline: Engineering Sciences and Techniques**  
**Specialty: Mechanical Engineering and Additive Manufacturing**

**On 08/11/2025 at 10H00 at the Conference Hall, F Building,  
Faculty of Sciences and Techniques, UAE  
Under the Theme**

**Microfluidic Chips Manufacturing Using Additive  
Manufacturing Techniques: Experimental Optimization and  
Predictive Modelling**

**Front of the jury composed of:**

First Name & Last Name	Establishment	Designation
Pr. AKOURRI Omar	FST of Tangier, UAE	President
Pr. SARSRI Driss	ENSA of Tangier, UAE	Reviewer
Pr. BOUCHAIB Abdelaziz	FST of Tangier, UAE	Reviewer
Pr. BELHOUIDEG Soufiane	ENSA of Beni Mellal, USMS	Reviewer
Pr. ZEKRAOUI Mustapha	FST of Beni Mellal, USMS	Examiner
Pr. FAKRI Nadia	FST of Tangier, UAE	Examiner
Dr. ERRAJOUANI Fatima Zohra	CHU Tangier	Guest
Pr. OUARDOUZ Mustapha	FST of Tangier, UAE	Supervisor

*Host Research Structure: Materials, Systems and Energy Engineering Laboratory*

## Abstract



Microfluidic technologies have transformed fields such as biomedical diagnostics, chemical synthesis, and environmental monitoring by enabling the precise manipulation of fluids at the microscale. However, their widespread adoption is constrained by the high cost, complexity, and infrastructure requirements of conventional fabrication methods. In response, Additive Manufacturing, specifically low-cost Fused Deposition Modelling (FDM), has emerged as a promising alternative for accessible and rapid microfabrication.

This thesis systematically investigates the capabilities, limitations, and optimization strategies of desktop FDM printers for microfluidic device fabrication. The research integrates three core phases: (1) experimental benchmarking of geometric resolution and print fidelity using PLA; (2) multi-material process optimization using the Taguchi Design of Experiments (DOE) methodology for PETG, TPU, and PMMA; and (3) development of interpretable predictive models based on Takagi-Sugeno Fuzzy Neural Networks (TS-FNN) for intelligent process control.

The results demonstrate that functional microchannels with widths as small as 100  $\mu\text{m}$  can be reliably produced under optimized conditions. However, material-specific challenges and nonlinear parameter interactions remain significant. The Taguchi DOE framework and TS-FNN models collectively enable a deeper understanding of process sensitivities, providing both optimization strategies and predictive capabilities. These outcomes establish a reproducible, data-driven workflow that supports low-cost, material-adapted microfluidic prototyping.

Collectively, this work advances the accessibility, reliability, and intelligence of 3D-printed microfluidic systems, supporting their broader adoption in both academic and industrial contexts.

**Keywords:** Microfluidics; Additive Manufacturing; Fused Deposition Modelling (FDM); 3D Printing; Process Optimization; Taguchi Design of Experiments; Predictive Modelling; Takagi-Sugeno Fuzzy Neural Network (TS-FNN); PLA; PETG; TPU; PMMA.