Ahlam OUARDI

Education & Research fellow at EMINES

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Education

Sept2024– Present **PhD Program**, *focus : Applied Mathematics*, Vanguard Center, Mohammed VI polytechnic university, Ben guerir, Morocco

Sept2022– Jun2024 **Education fellow**, *focus : Mathematics*, Mohammed VI polytechnic university, Ben guerir, Morocco

Sept2019– Sept2022 **Master of science**, *Industrial Management, focus: mining*, EMINES School of Industrial Management, Ben guerir, Morocco
- **Master thesis:**"*Modelling and stabilization of port Hamiltonian systems,*"

Sept2017– Jun2019 **Bac+2**, *Mathematics, physics and engineering sciences*, Preparatory classes (CPGE), Beni Mellal, Morocco
- **TIPE project** " *Automation of transport systems: Radar car,*"

Sept2017 **baccalaureate**, *Mathematics sciences*, El Kindi high school, Fquih ben salah, Morocco

Research experiences

Sept2024– Dec2024 **Researcher**, University of Wuppertal, Germany
- Analyze eddy current brakes, which is a device used to slow down a moving object, like a train, without physical contact, from a port-Hamiltonian perspective, by developing a port-Hamiltonian formulation of existing models, in mathematical terms, an eddy current brake is described by the coupling between the magnetic field (described by a certain simplification of Maxwell's equations) and the equations of motion of the rotating disc, this coupling occurs via the Lorentz force. To achieve this, we formulate the appropriate Dirac structures and Hamiltonian, and identify the suitable function spaces for the flows and efforts.

Avr2022– Sept2022 **Researcher (Intern)**, Mohammed VI polytechnic university, Vanguard center, Morocco
- Analyzed linear port Hamiltonian systems concerning the derivation of motion equations based on the physical laws governing the model's dynamics. Developed a mathematical model to describe a flexible beam by manipulating the wave and Euler-Bernoulli equations (motivated by an aeronautical issue: vibrations of flexible wings leading to instability aircraft). Defined appropriate boundary conditions that ensure the well-posedness of the second-order port Hamiltonian system. Stabilized beam vibrations through state feedback applied to external ports and proving exponential stability under certain conditions using the Gearhart theorem. Discretization of the continuous infinite-dimensional system using the shifted grid finite difference method and performing numerical simulations to compare continuous and discrete Hamiltonian.

Jui2021– Sept2021 **Research engineer (Intern)**, MAScIR Moroccan foundation for advanced science innovation and research, microfluidics and embedded system laboratories, Morocco
- Establish scientific research on the operation of a microfluidic chip for tuberculosis diagnosis by isothermal DNA amplification. Propose a more efficient method based on nuclear magnetic resonance.

- Validated the Proof Of Concept of the corn dry matter analysis system: infrared spectrometer. Collect data from different samples, prove correlation between spectrum samples and their dry matter content.
- Analyze sweat components to detect glucose during perspiration using a portable device.

Teaching experiences

Sept2024–present **Math Teacher**, *EMINES*, School of Industrial Management, Ben guerir, Morocco

- Designed and taught the course *"Mathematical Modeling"* for 4th-year engineering students, covering dynamical systems, differential equations, and real-world applications.
- Led oral examination sessions ("Khôlles") for 1st and 2nd-year students in mathematics.

Academic projects

- **Mechatronics**
  Manufacture an electric kart: Draw up a mechanical and electrical study and the production of an electric kart in compliance with automotive standards: study of the propulsion system, stability study, preparation of the kart definition file...
- **Biomedical engineering**
  Simulation of flow in the human bronchial tree: Model lung function, by numerically solving the equations governing airflow in a tube given by the theoretical study pre-established in the case of a rigid and flexible bronchus (Navier-Stokes equation). Then generalize these particular results to a multi-generation lung tree.
- **Industrial management**
  Stone paper industry from calcite: Study the technical and economic feasibility of a new OCP business focusing on the waste rock-based stone paper industry for the recovery of mining waste, analyze the waste rock and investigate the separation of $CaCO_3$ from other components.
- **Statistics**
  Economic impact of COVID19: Establish a statistical study of the impact of the health crisis on the global economy. Predict the growth of countries' GDP and public debt.
- **Cryptography**
  Extension of encryption and key exchange protocols using polynomials: Study and apply the Diffie-Hellman protocol.
- **Computational fluid dynamics**
  Fluid flow simulation: Modeling the aerodynamic behavior of Newtonian viscous flow using OpenFOAM software and visualization via Paraview.

Research areas

- Theoretical mathematics, Control theory
- Mathematical modeling, Numerical analysis, Machine Learning, Data-driven modeling
- Biomedical engineering, Computational fluid dynamics, mechanics
- Optimization

Interests

- Research head : Moroccan Mathematical Community
- Participant at : Applied Machine Learning Days, et TECHINNOV DAY
- Participant at : Mathematics and Decision Conference, The Vanguard Center