0D/1D Performance Modelling of 4-stroke Dual-Fuel Marine Engines

Position:	Master student internship (H/F)
Location:	LHEEA - ECN, Nantes, France
Team:	D2SE - Decarbonisation & Depollution of Energy Systems
Co-Supervisors:	François Prevost, Aaqif Ahmed
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Context

Sea transport accounts for 90% of the world's trade in goods and merchandise. Greenhouse gas (GHG) emissions from shipping contribute to nearly 3% of global carbon emissions. In a bid to accelerate the energy transition of international shipping, the IMO in 2023 revised its GHG reduction strategy, targeting a minimum 20% reduction in emissions by 2030 (compared to 2008 levels), 70% reduction by 2040, and ultimately achieving net-zero around 2050.

The shipping industry has been focusing on more environmentally friendly means of propulsion and electric power generation. In this context, dual fuel engines are one of the most promising solutions for the energy transition. These engines can operate in either classical diesel mode or dual fuel (DF) mode, burning cleaner alternative fuels such as LNG, methanol, ammonia, along with pilot diesel fuel to initiate ignition. This dual fuel operation leads to reduced nitrogen oxide (NOx), carbon dioxide (CO2), as well as almost complete elimination of particulate matter (PM) and sulphur oxide (SOx) emissions.

Within this context, project TNTM – *Transformation Numérique du Transport Maritime*, a collaborative R&D project lead by shipping company CMA CGM, is put into action with several companies, industry leaders, universities, and research centers. The aim is to reduce fuel consumption and emissions by improving the operational efficiency of container ships by leveraging data and simulations of various processes. The D2SE team at the LHEAA-ECN lab is responsible for modeling of the global ship energy consumption during navigation, with a particular focus on the internal combustion engine physics.

Master thesis subject

Auxiliary engines play a critical role in a ship energy system, producing power to satisfy the hotel (electrical) load demands of the vessel, providing electricity for lighting, HVAC, ventilation, pumps, navigation systems, and other equipment. These engines are coupled with alternators, and provide electrical power to the main switchboard, which allocates power according to demand.

To understand the performance and behavior of these engines, modelling and simulation are fundamental. The objective is to **develop and calibrate a 0D/1D model** of a 4-stroke DF auxiliary engine (**Wärtsilä 34DF**) operating on fuel oil and LNG, complete with the supporting subsystems (turbocharger, air loop, etc.). The candidate will first carry a research review to understand the state of the art and physics of dual fuel internal combustion engine modelling, and calibration methodologies.

The model will be developed on Simcenter AMESIM, which is a multi-domain commercial software used in the development and modelling of complex multi-physics systems. As the operation of the engine is different in Fuel and LNG mode, specific models need to be developed for the two, one adapted to diesel mode, and the other to dual-fuel. Based on data availability, project needs, and interest, a decision will be made on which to prioritise.

Once the model is developed, the next main step is to calibrate and optimize the various sub-models to obtain performance-matching data, within defined error margins. Depending on time, the final step is to validate the performance of the complete model with operational data, simulating the model on various operating points from a voyage to test the accuracy and predictive ability of the model.

A final detailed report documenting the methodology, results, and analysis of the developed models is necessary to complete the internship.

Candidate Profile

The candidate should be a 2nd year Master's student or Bac+5 with a specialization in Mechanical Engineering, Applied Mathematics, Thermodynamics, Energetics, or related topics.

The prerequisites for this internship are:

- Excellent knowledge of the physics of IC engines and numerical modelling
- Good knowledge of Simcenter Amesim or GT-Power software
- Basic competency in Python / Matlab
- Knowledge of optimization techniques is a bonus

Applications & Schedule

Candidates are invited to provide a CV and a motivation letter to the email address: **aaqif.ahmed@ec-nantes.fr**. Mention 'TNTM Internship' in the subject line.

The candidate is expected to start February/March 2026, with the internship duration lasting **6 months**.

Conditions

The candidate will be funded for six months at the French legal level for internships in public establishments (~630 €/month net; 4.35 €/hour in 2024; may be subject to change in 2026). The working duration is 7 hours/day, for a total of 35 hours/week.

The candidate will be hosted within the D2SE team in LHEEA Lab at Ecole Centrale de Nantes.