Master Internship (Stage de fin d'étude) leading to a potential industry-funded PhD position

Internship description

CEREA (*École des Ponts*, *Institut Polytechnique de Paris*), in collaboration with **EDF R&D Chatou**, is seeking a motivated and talented intern (Master 2 or final-year engineering student) for a 5–6 month research internship on **Neural Operator–based surrogate modeling of radiative heat transfer in combustion**.

The project, supervised by Dr. Sibo Cheng (CEREA, ENPC)**,** Dr. Fathia Nimra (EDF R&D) and Dr. Jean-Louis Consalvi (Aix-Marseille University), aims to develop machine-learning surrogates capable of efficiently reproducing the behavior of the Radiative Transfer Equation (RTE) used in combustion simulations.

Radiative heat transfer is a dominant mechanism in large-scale fires, making accurate prediction essential but challenging due to the complexity of the RTE. The latter is a high-dimensional integro-differential equation describing the spectral radiative intensity as it varies with position, direction, and wavenumber, governed by the balance of emission and absorption in participating media such as gases and soot. Traditional numerical solvers (*Modest & Mazumder,2021*) like the Discrete Ordinates and Finite Volume Methods often become computational bottlenecks, particularly when detailed radiative properties are involved. Scientific Machine Learning, and specifically DeepONets *(Lu et al., 2021*), provides an efficient alternative by learning the solution operator of the RTE, enabling rapid prediction of radiative fields across varying conditions without re-solving the equation each time.

Inspired by recent developments such as *Lu & Wang (2024, Proceedings of the Combustion Institute)*, the internship explores physics-informed neural operators to emulate radiation fields in complex combustion environments, providing a computationally efficient alternative to traditional solvers. The objective is to develop and validate a DeepONet framework capable of predicting the angular-dependent specific intensity field for 3D RTEs, using lower-dimensional analytical solutions as benchmarks for accuracy and scalability.

In the second stage of the internship, as well as during the potential PhD position, the student is encouraged to develop new methods for addressing sparse observation problems using generative AI models in the function space (*Wang et al., 2025*) associated with RTE, with the expectation that these methods will also be generalizable to other dynamical systems relevant to combustion theory.

This internship is part of an ongoing ENPC–EDF collaboration on AI-enhanced physics-based modeling**,** and may lead to a PhD opportunity (with a **very competitive CIFRE-funded salary**), depending on project outcomes and funding availability.

Project focus

The intern will contribute to the following research objectives:

- **Neural Operator Design:** Implement DeepONet or Fourier Neural Operator architectures in to approximate solution operators of the RTE.
- **Physics-informed Training:** Integrate physical constraints (absorption, emission, boundary conditions) into the loss functions.
- **Benchmarking:** Compare the neural operator's performance with classical radiative solvers provided by domain experts on canonical test cases.
- **Extenstion to generative AI:** Explore coupling of neural operators with generative AI frameworks such as the diffusion model (Wang et al., 2025).

About CEREA and EDF

CEREA is a world-leading environmental modeling laboratory based at *École des Ponts (ENPC)*, *Institut Polytechnique de Paris* (*QS ranking 41)* specialized in data assimilation, uncertainty quantification, and scientific machine learning for environmental and geophysical systems.
EDF R&D Chatou hosts one of Europe's most advanced industrial research centers in energy systems, with ongoing efforts in multiphysics simulation and combustion modeling.

Requirements

- **Academic Level:** M2 or final-year engineering student in Applied Mathematics, Computer Science, Physics, or Energy/Combustion Engineering with a solid statistics background.
- **Eligibility:** Students with European nationalities are prioritised.
- **Skills:**
    - Strong programming experience in **Python** and **PyTorch** (or equivalent frameworks)
    - Interest in **machine learning for physical systems**
    - Good communication and scientific writing skills (English required; French is not necessary but a plus)
- Prior exposure to PDE, computational phsyics, or surrogate modeling is a plus but not mandatory.

Supervisors

To apply, please submit your CV (including any relevant project or research experience), Master course transcript (M1 and M2 if available), a brief cover letter in English or French, to

Dr. Sibo Cheng, sibo.cheng@enpc.fr

Dr. Fathia Nimra, fatiha.nmira@edf.fr

Dr. Jean-Louis Consalvi, jean-louis.consalvi@univ-amu.fr

Please entitle your email with **[Master Intern Application CEREA-EDF]** (feel free to write in Enlgish or French). Selected candidates will be contacted for further discussions.

Benefits

- About 650€ per month for the Allowance during the internship
- 50% reimbursement of Navigo Monthly Card (transport in Paris)
- Remote working could be possible up to 1-2days per week

references (recommend to read before application)

M.F. Modest and Sandip Mazumder. Radiative heat transfer. Academic press, 2021.

L. Lu, P. Jin, G. Pang, Z. Zhang, G. E. Karniadakis, Learning nonlinear operators via deeponet based on the universal approximation theorem of operators. Nature Machine Intelligence, 3(3), 03 2021.

Lu, X. and Wang, Y., 2024. Surrogate modeling for radiative heat transfer using physics-informed deep neural operator networks. *Proceedings of the Combustion Institute*, *40*(1-4), p.105282.

Wang, S., Dou, Z., Liu, T.R. and Lu, L., 2025. Fundiff: Diffusion models over function spaces for physics-informed generative modeling. *arXiv preprint arXiv:2506.07902*.