

Research Studentships (for students of a course that does not award an academic degree)

Applications are open for 1 Research Studentship, within the Recovery and Resilience Plan (RRP) project “Alliance for the Energy Transition”, under the following conditions:

Scientific Area: Department of Electrical and Computer Engineering

Admission Requirements: *to hold a bachelor or master degree and be enrolled at a course that does not award an academic degree and it is integrated in the educational project of a higher education institution, performed in association or cooperation with one or several R&D units;*

Workplan: This research fellowship will focus on the development of virtual models (digital twins) for studying and detecting abnormal operating conditions (predictive diagnostics of anomalous behaviors) in distribution transformers using the finite element method (FEM).

Distribution transformers are critical components within electrical networks, and their reliable operation is essential to maintain service continuity and reduce economic losses resulting from unexpected outages. Given their importance, continuous monitoring and fault diagnostics are crucial—especially as machine learning algorithms play an increasingly prominent role in predictive maintenance and reliability strategies.

However, these techniques often rely on datasets featuring signals associated with specific transformer faults, which are challenging to obtain due to the complexity of reproducing such conditions. This research will therefore contribute to the development and simulation of virtual models (digital twins) of commercial distribution transformers—both healthy and faulted—using FEM techniques.

The virtual models will consist of highly accurate and comprehensive 2D and 3D representations, which include:

- 1) Precise geometries, material properties, and operational specifications of real transformers;
- 2) Thermal effects on winding insulation and core materials;
- 3) Magnetic field distortions caused by structural asymmetries or core saturation;
- 4) Transient electrical behavior in response to load variations;
- 5) Short-circuit forces and winding deformation effects;
- 6) Realistic boundary conditions representing electromagnetic field distribution in space;
- 7) Calculation of iron and copper losses;
- 8) Oil circulation effects within the transformer, with implications for anomaly detection.

A comparative analysis of 2D and 3D virtual models will be conducted under abnormal behavior scenarios, followed by the creation of a signal database from simulations with varying load levels and anomaly intensities. This dataset will be used to train and validate multiple artificial neural network architectures based on Multi-Layer Perceptrons (MLPs). These networks will later be exposed to previously unseen experimental signals from real transformers, successfully diagnosing anomalies solely from artificially generated signals derived from the virtual models.

Legislation and Regulations: Statute of Scientific Research Fellow, approved by Law nr. 40/2004, of August 18, as worded by Decree-Law nr. 123/2019, of August 28; IST Regulation of Scientific Research Fellowships, available on https://drh.tecnico.ulisboa.pt/files/sites/45/despacho_8532_regulamento_bolsas.pdf

Workplace: The work will be developed at Instituto de Engenharia Mecânica (IDMEC) under the scientific supervision of Professor Paulo Branco, Professor João Fernandes and Dr. Andrés Zuniga

Duration: The research fellowship(s) will have the duration of 10 months. It's expected to begin in October/2025, and the contract is not renewable.

Monthly maintenance allowance: the amount of the monthly maintenance allowance is €1309,64, being the payment method by Wire Transfer.

Selection methods: The selection methods to be used will be as follows: curriculum evaluation (academic background, currently master's grade, suitability for the role) and motivation letter, with corresponding weightings of 50%, 25%, and 25%, respectively. The criteria will be assessed on a scale from 1 to 10.

Composition of the selection Jury: President: Prof. Paulo José da Costa Branco

Effective members: Prof. João Filipe Pereira Fernandes and Dr. Andrés Alejandro Zuñiga Rodríguez

Announcement/ notification of the results: The final evaluation results will be communicated to all applicants by email.

Deadlines and procedures of complaint and appeal. A complaint may be lodged from the final decision, or an appeal to the Executive Board of IST, within 15 working days counted from the respective notification.

Application deadline and formalization: The call is open from September 15 until September 26, 2025.

It is mandatory to formalize applications with the submission of the following documents: i) B1 Form – Fellowship application (<http://drh.tecnico.ulisboa.pt/bolseiros/formularios/>); ii) *Curriculum Vitae*; iii) academic degree certificate, where applicable; iv) proof of enrollment at a course that does not award an academic degree; v) motivation letter; vi) declaration on honour that the applicant does not exceed with this contract an accumulated period of two years in this type of studentship, continuously or with interruptions.

Applications must be submitted to the email pbranco@tecnico.ulisboa.pt, including the reference of the Call Notice (Unique identifier) in the subject line of the email.