The Centre for Ocean Energy Research (COER) in Maynooth University has some internship opportunities. These are an unpaid internships, although interns may avail of grants, or similar, (eg Erasmus), to support their internship expenses.

What we do offer, is the possibility to participate in a dynamic research environment, working on a topical research area, amongst highly motivated PhD students, postdocs, and other interns. Intern supervision is jointly managed by the COER Director, Prof. John Ringwood, and one or more of the lab's postdocs/PhD students. Interns are registered as students of Maynooth University, so have access to all University facilities as well as the COER lab facilities - desk space in the COER lab, computing and network facilities, etc.

Some more information on our activities, publications and people is available at: http://www.eeng.nuim.ie/coer/

For more information or to apply contact: CarrieAnne.Barry@mu.ie

Internship project 1: Fractional-order modelling of Wave Energy Converters

Based on Newton's second law, the classical way to describe the motion of wave energy converters (WEC) is by considering the so-called Cummins equation, which is a second order differential equation involving a convolution term describing the radiation force. Thus, given the natural relationship between fractional derivatives and integro-differential operators, a promising alternative to describe the radiation term is by considering the different tools that offer fractional calculus theory.

In order to explore the relationship between fractional-order differential equations and the dynamic of wave energy converters (WECs), the Centre for Ocean Energy Research (COER) from Maynooth University, Ireland, is looking for an excellent intern student with strong mathematical background (Analysis and Numeric of Differential Equations) to develop research on it and related topics.

The main tasks of the project in which the candidate will be involved are described in the following:

- To review the main definitions and properties of fractional-order derivatives and fractional integrals.
- To review the analysis and numerics of fractional differential equations.
- To review linear dynamic of WEC.
- Model and/or simulate a fractional model describing the dynamics of a WEC.

References:
- Gutierrez, R.E., Rosario, J.M. and Tenreiro Machado, J., 2010. Fractional order calculus: basic concepts and engineering applications. *Mathematical problems in engineering*, 2010.
- Ringwood, J.V., Bacelli, G. and Fusco, F. Energy maximising control of wave energy converters, IEEE Control Systems Magazine, Vol.34, No.5, Oct. 2014, pp 30-55. (https://ee.maynoothuniversity.ie/jringwood/Respubs/J219CSM.pdf)