School of Computing, Engineering, and the Built Environment
Edinburgh Napier University

PHD STUDENT PROJECT

Funding and application details

Funding status: Self funded students only

Application instructions:
Detailed instructions are available at https://blogs.napier.ac.uk/scebe-research/available-phd-student-projects/

Prospective candidates are encouraged to contact the Director of Studies (see details below) to discuss the project and their suitability for it.

Project details

Supervisory Team:

- DIRECTOR OF STUDY: Vladimir Bratov (Email: V.Bratov@napier.ac.uk)
- 2ND SUPERVISOR: Islam Shyha

Subject Group: Engineering & mathematics

Research Areas: Solid Mechanics, Metallurgy, Applied Mathematics, Mathematical Modelling, Computational Mathematics, Engineering Mathematics

Project Title: Multiscale Numerical Approaches for Materials Design and Engineering

Project description:

The Engineering and Mathematics Group within the School of Computing, Engineering and the Built Environment is inviting applications for a research studentship in developing novel numerical approaches for design and engineering of composite materials and metamaterials leading to the award of a PhD degree.

Currently, the progress in the area of design of new advanced materials is greatly limited by the absence of reliable numerical approaches that can be employed to predict various properties of a material based on its composition and production technology. This regards mechanical properties, strength, electrical properties,

dynamic wave propagation properties, etc. As a result, new findings in the area are usually an outcome of extensive, time- and resource-consuming experimental work.

This doctoral research project aims to develop new multi-scale numerical approaches combining classical numerical techniques of continuum mechanics (i.e. Finite Element Method, FEM) with discrete 3D models giving a possibility to simulate and analyse various local material properties. Another important part of the project will be the development of a strategy to optimise desired material properties based on advanced evolutionary algorithms or another AI technique.

Since the core objective is to develop numerical approaches for simulations in solid mechanics, this research requires an excellent understanding of solid mechanics and elasticity theory, solid body dynamics, wave mechanics, plasticity, fracture mechanics and numerical methods for solution of equations arising in the above areas (i.e. most probably FEM). Furthermore, the research involves interconnection to discrete approaches and evolutionary computations/AI, so it is desirable that a candidate has an understanding of probability, combinatorics, linear algebra and discrete mathematics. This research will include a big part of code development, so experience with programming (ex. PYTHON, FORTRAN, ANSYS APDL, C++) is essential.

References:

[1] E Borodin, A Jivkov, et al. Optimisation of rGO-enriched nanoceramics by combinatorial analysis. Materials & Design, 2021

[2] Munk, D.J., Vio, G.A. & Steven, G.P. Topology and shape optimization methods using evolutionary algorithms: a review. Struct Multidisc Optim 52, 613–631 (2015).

[3] Budarapu, P.R., Rabczuk, T. Multiscale Methods for Fracture: A Review . J Indian Inst Sci 97, 339–376 (2017)

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Solid Mechanics, Applied Mathematics

Subject knowledge:

- Numerical methods in engineering

Essential attributes:

- Strong background in solid mechanics, mathematics and numerical methods.
- A good Bachelor's Hons degree (2.1 or above or international equivalent) and/or Master's degree in a relevant subject (engineering, mathematics, physics, or related subject).
- Strong motivation, with evidence of independent research skills relevant to the project.
- Good communication skills
- Good programming skills

Desirable attributes:

- Familiarity with 3D printing technologies is highly desirable but not necessary.
- Knowledge of probability and discrete mathematics.

- Familiarity with evolutionary algorithms and AI is highly desirable but not necessary.