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: Emma Hart

Subject Group: Engineering & mathematics

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

Project Title: Novel metamaterials for mechanical waves attenuation

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 metamaterials for high-energy mechanical waves attenuation leading to the award of a PhD degree.

Development of effective protection against intensive mechanical waves (vibration induced by high-speed transport, seismic events, etc.) is an extremely important and challenging research area. Vibrations can be undesirable and/or harmful in various applications, including buildings, machinery, and electronic devices.

Metamaterials, metasurfaces and metastructures offer unique properties that can be utilised to effectively control and mitigate vibrations. While extensive research is ongoing in this field, a majority of the questions regarding the design and production of the most efficient metamaterial for a specific application remain without answers.

This doctoral research project aims to develop new approaches in design of metamaterials, metasurfaces and metastructures combining classical numerical techniques of continuum mechanics (i.e. Finite Element Method, FEM) with cutting-edge evolutional algorithms and AI utilised to discern optimal metamaterial configurations. Another important part of the project will consist in production (ex. utilising 3D printing) and laboratory testing of optimal metamaterial designs.

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 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] Alzaidi, A.S.M., Kaplunov, J., Prikazchikova, L. et al. The effect of contact conditions on the performance of flexural seismic metasurfaces. Z. Angew. Math. Phys. 73, 194 (2022). https://doi.org/10.1007/s00033-022-01822-9

[2] Gupta, A., Sharma, R., Thakur, A. et al. Metamaterial foundation for seismic wave attenuation for low and wide frequency band. Sci Rep 13, 2293 (2023). https://doi.org/10.1038/s41598-023-27678-1

[3] 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).

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.