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

PHD STUDENT PROJECT

Application instructions:
Detailed instructions are available at :
https://www.napier.ac.uk/research-and-innovation/doctoral-college/how-to-apply

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: Dr Chennakesava Kadapa (Email: c.kadapa@napier.ac.uk)
- 2ND SUPERVISOR: Dr Fadi Kahwash

Subject Group: Engineering & Mathematics

Research Areas: Engineering, Mathematics

Project Title: Advanced Computational Methodologies for Smart Multifunctional Composites

Project description:

Smart multifunctional composites (MFCs) such as electroactive polymers, magnetoactive polymers, hydrogels, photosensitive polymers, liquid-crystal elastomers etc., are increasingly being used for various applications in soft robotics, precision drug delivery, tactile sensors and shape morphing. A major challenge in the computational modelling of these MFCs is their inherent thin geometries. Moreover, their deformation response is highly nonlinear and incompressible, typically modelled with the extended versions of hyperelastic constitutive models. The combination of thin geometries, highly nonlinear stress-strain response and the incompressible nature of deformations makes it extremely challenging to develop computational methodologies for these smart multifunctional composites.

This project will develop state-of-the-art beam and shell finite elements for simulating coupled multiphysical interactions of smart MFCs under extreme environments by considering anisotropic, viscoelastic, transient and multiphysical effects. This project includes collaborations with other institutions at the national and international levels.

The project consists of the following major activities:

- Develop beam and shell finite elements for smart multifunctional composites.
- Incorporate viscoelastic and elastodynamic effects.
- Validate the simulation framework.
- Disseminate research outputs in journals and at conferences.

References:

[1] Kadapa, C. and Hossain, M. (2022) ‘A unified numerical approach for soft to hard magneto-viscoelastically coupled polymers’, Mechanics of Materials, 166, p. 104207.

[2] Kadapa, C., Li, Z., Hossain, M. and Wang, J. (2021), ‘On the advantages of mixed formulation and higher-order elements for computational morphoelasticity’, Journal of Mechanics and Physics of Solids, 148, p. 104289.

[3] Kadapa, C. and Hossain, M. (2020) ‘A robust and computationally efficient finite element framework for coupled electromechanics’, Computer Methods in Applied Mechanics and Engineering, 372, p. 113443.

[4] Kadapa, C., (2021) ‘A simple extrapolated predictor for overcoming the starting and tracking issues in the arc-length method for nonlinear structural mechanics’, Engineering Structures, 234, p. 111755.

Candidate characteristics

Education:

A first-class honours degree, or a distinction at master level, or equivalent achievements in Mechanical Engineering, Aerospace Engineering, Civil Engineering, Mathematics

Subject knowledge:

- Solid Mechanics
- Continuum Mechanics
- Finite Element Method
- Programming languages

Essential attributes:

- Experience in programming for finite element methods.
- Competent in programming in at least one of C, C++, Fortran, Python, MATLAB or Julia.
- Basic knowledge of modelling and simulation technologies.
- Good written and oral communication skills.
- Self-motivation, with evidence of independent learning.

Desirable attributes:

- Programming in C++.
- Experience in using simulation software such as ANSYS, Abaqus, and COMSOL.
- Knowledge of composite materials.
- Knowledge of electromagnetism.