PX920-7.5 Homogenisation of Nonlinear Heterogeneous Solids

20/21

Department
Physics
Level
Taught Postgraduate Level
Module leader
Lukasz Figiel
Credit value
7.5
Module duration
10 weeks
Assessment
60% coursework, 40% exam
Study location
University of Warwick main campus, Coventry

Description

Introductory description

N/A.

Module web page

Module aims

Provide students with understanding and practical aspects of homogenisation methods for predicting overall macroscopic response of heterogeneous solids with nonlinear material constituents through lectures, case studies and computer-lab (workshop) activities.

Outline syllabus

This is an indicative module outline only to give an indication of the sort of topics that may be covered. Actual sessions held may differ.

Topic 1: Fundamentals of Nonlinear Solid Mechanics
a. Theory of finite deformations - brief recap

b. Nonlinear constitutive equations (e.g. hyperelasticity, plasticity, viscoplasticity)
i) Phenomenological
ii) Physically-based
iii) Data-driven
Topic 2: Methods for predicting macroscopic properties of nonlinear heterogeneous solids
a. Mean-field approaches
i) Self-consistent methods
ii) Mori-Tanaka methods
b. Homogenisation
i) Homogenisation for linear periodic heterogeneous materials
ii) Homogenisation for nonlinear periodic heterogeneous materials
Topic 3: Extensions to multi-physics problems in nonlinear heterogeneous solids
a. Mean-field approaches
b. Homogenisation

Learning outcomes

By the end of the module, students should be able to:

- Understand sources of material nonlinearity.
- Be familiar with common constitutive models.
- Be able to implement nonlinear constitutive models into nonlinear solution process.
- Understand the concept of homogenisation.
- Apply a nonlinear mean-field approach to a simple problem.
- Be able to design and implement a simple two-scale nonlinear simulation process.

Indicative reading list

[1] J. Fish, Practical Multiscaling, Wiley, 2013.
[2] S. Torquato, Random heterogeneous materials: Microstructure and Macroscopic Properties. Springer, 2002.

Subject specific skills

Understand sources of material nonlinearity
Be familiar with common constitutive models
Be able to implement nonlinear constitutive models into nonlinear solution process
Understand the concept of homogenisation
Apply a nonlinear mean-field approach to a simple problem
Be able to design and implement a simple two-scale nonlinear simulation process

Transferable skills

Programming, data analysis, problem-solving

Study

Study time

Type	Required
Lectures	6 sessions of 2 hours (16%)
Practical classes	2 sessions of 2 hours (5%)
Private study	44 hours (59%)
Assessment	15 hours (20%)
Total	75 hours

Private study description

Reading etc

Costs

No further costs have been identified for this module.

Assessment

You do not need to pass all assessment components to pass the module.

Assessment group D

	Weighting	Study time	Eligible for self-certification
Assessment component			
Computational Project	60%	10 hours	No
One piece of assessed work based on the numerical implementation of homogenisation procedure.			
Reassessment component is the same			
Assessment component			
Viva voce Exam	40%	5 hours	No

	Weighting	Study time	Eligible for self-certification
30 minutes.			

Reassessment component is the same

Feedback on assessment

Written annotations to submitted computational notebooks \r\nVerbal discussion during viva voce exam \r\nWritten summary of viva performance

Past exam papers for PX920

Availability

Courses

This module is Core optional for:

- Year 1 of TPXA-F344 Postgraduate Taught Modelling of Heterogeneous Systems

This module is Core option list A for:

- Year 2 of TPXA-F345 Postgraduate Taught Modelling of Heterogeneous Systems (PGDip)