Imperial College London

Department of Civil and Environmental Engineering

Nonlinear Structural Analysis

Course leader:	Professor Bassam Izzuddin
Other contributors:	
Module status:	Core H2A3 Elective H2A2, H2A1, H2U5
Pre- or co-requisites:	
Term:	Spring
Contact hours:	30
ECTS units:	MSc: 5 / MEng: 6
FHEQ Level:	7
Assessment:	Coursework, written examination

1.0 Aims

- To present systematic procedures for geometric and material nonlinear structural analysis.
- To introduce and encourage the use of advanced nonlinear analysis software and to explore the significance of common nonlinear phenomena, particularly in relation to the structural response under extreme events.

2.0 Syllabus

- Fundamentals of geometric nonlinearity for discrete structural systems.
- Principles of stability and buckling analysis for discrete structural systems.
- Nonlinear solution procedures for tracing equilibrium paths.
- Geometrically nonlinear finite elements for one-dimensional structural systems.
- Materially nonlinear finite elements for one-dimensional structural systems.
- Nonlinear dynamic analysis of discrete structural systems (only MSc).

No.	Topic	Staff
01	Lecture: Fundamentals of geometric nonlinearity for discrete structural systems.	BAI
02	Lecture: Principles of stability and buckling analysis for discrete structural systems	BAI
03	Lecture: Principles of stability and buckling analysis for discrete structural systems Tutorial	BAI
04	Lecture: Principles of stability and buckling analysis for discrete structural systems Tutorial	BAI
05	Lecture: Nonlinear solution procedures for tracing equilibrium paths Computer lab	BAI

06	Lecture: Geometrically nonlinear finite elements for one-dimensional structural systems Project	BAI
07	Lecture: Materially nonlinear finite elements for one-dimensional structural systems Project Computer lab	BAI
08	Lecture: Materially nonlinear finite elements for one-dimensional structural systems Project	BAI
09	Lecture: Nonlinear dynamic analysis of discrete structural systems Project Computer lab	BAI
10	Lecture: Nonlinear dynamic analysis of discrete structural systems Project Computer lab	BAI

3.0 Intended learning outcomes

On successfully completing this course unit, students will be able to:

- Distinguish between linear and nonlinear structural analysis.
- Recognise types of problem for which nonlinear structural analysis is necessary.
- Understand principles of stability for multi-degree of freedom structural systems.
- Appreciate the basis of sophisticated and simplified buckling analysis methods.
- Use equilibrium paths to characterise the nonlinear structural response.
- Understand basic incremental iterative solution procedures for tracing equilibrium paths.
- Appreciate the fundamentals of nonlinear finite element discretisation, including geometric and material nonlinearity.
- Appreciate the use of hierarchic processes in tackling complex problems.
- Recognise the role of analogies in gaining greater understanding.
- Use nonlinear structural analysis software.
- Perform simplified buckling analysis.
- Use computers for simulations.
- Solve a nonlinear system of equations.
- Apply techniques of linear algebra.

4.0 Teaching methods

Handouts are provided for the various topics, and extensive use is made of the visualiser to elaborate on concepts and application issues. All material, including handouts, visualiser lecture notes and solutions to tutorial problems, are placed on Blackboard for student access. Computer laboratory sessions are also provided making use of screen projection to introduce finite element analysis software.

5.0 Assessment

Assessment will be via written examination and project coursework, with respective marks split of 70:30.

6.0 Recommended textbooks

Category as defined by Central Library:

C = Core, S = Supplementary

X	No textbooks are recommended.

7.0 Subject threads

The table below shows how the themes of design, sustainability and health & safety risk management are embedded in the curriculum (as defined by the JBM degree guidelines).

Key: Primary (P), Secondary (S) and Contributory (C).

Design	Health & Safety Risk Management	Sustainability
S	**S**	**-**