CE 403 NONLINEAR STRUCTURAL MECHANICS

Co-ordinator: Dr. B A. Izzuddin, Room (325), b.izzuddin@imperial.ac.uk

Status : Elective

Lecturers: Professor D Lloyd Smith (DLS) (Room 426) (Autumn Term)
Dr B A Izzuddin (BAI) (Room 325) (Spring Term)

Structure: 46 lectures, 14 tutorial hours

Links: CE 301, (CE 308: Recommended).

Aims

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

SYLLABUS

Systematic Plastic Limit Analysis of Framed Structures (DLS) (Autumn Term)
Mesh and Nodal forms of static and kinematic laws, static-kinematic duality. Plastic collapse, the structural matrix relations, complementarity. Plastic limit analysis, the upper and lower bound theorems, representation as dual linear programs. Sysematic use of Microsoft Excel / Corel Quattro Pro / Lotus 1-2-3. Application to steel, reinforced concrete and masonry construction. Displacements and plastic hinge rotations at collapse.

Modelling and Assessment of Nonlinear Structural Behaviour (BAI) (Spring Term)
Fundamentals of geometric nonlinearity for discrete structural systems. Principles of stability and buckling analysis. 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. Use of ADAPTIC for nonlinear structural analysis, with application to static and dynamic problems.

Coursework and Submission Dates

Plastic limit analysis of a framed structure (Week 10).
Students should be able to demonstrate skills in modelling, using a proprietary spreadsheet, and interpreting the results for relevance to design.

Geometric and material nonlinearity (Week 22).
Students should be able to demonstrate skills in modelling a number of practical structures for nonlinear analysis, in applying nonlinear analysis software, and in assessing the results for accuracy and for significance in practical design.

Assessment
A 3-hour written examination, beginning of the Summer Term, contains 6 questions. Rubric: “Answer 4 Questions”. (Contributes 60% of the marks). Two short projects for coursework (each contributes 20% of the marks).

Recommended Textbooks/Reading:
Neal, B. G., The Plastic Methods of Structural Analysis, 1st Edition, Chapman & Hall, 1956.

Learning Outcomes
- Students should gain insight into the types of structural problems for which material and geometric nonlinearity may have a significant bearing on design.
- They should acquire knowledge of the procedures involved in systematic and practical nonlinear analysis.
- They are expected to be able to use industry-standard software for nonlinear analysis, having due regard for the factors influencing accuracy, and to assess the significance of common nonlinear phenomena in relation to design