CE 301 STRUCTURAL MECHANICS

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Status: Core Subject

Lecturers:	Dr M. A. Wadee (MAW) (Room 443) Dr C. M. Tsang (CMT) (Room 328B) Dr K. Ramachandran (KR) (Room 408)
Structure:	50 contact hours of lectures, tutorials and project work
Links:	See below

Introduction

The third year Structural Mechanics module begins to examine the basic effects of instabilities in simple structural systems. This leads to the analysis of structural elements – particularly those made of steel - that are prone to buckling. Plasticity in frames is also studied to cover statically indeterminate frames and more complicated loading cases. Free and forced vibrations of simple structures are covered, whose importance can be observed in many structural scenarios such as in long-span bridges, tall buildings and designing against seismic action. These topics are central to day-to-day structural analysis and design in practice.

Aims

To build on the work in structural mechanics in years 1 and 2 to cover more advanced material essential to understanding of structural behaviour particularly near the ultimate limit state where structural failure is to be considered and necessarily avoided.

Links with Other Course Modules

The module requires good analytical skills and applies techniques learnt from the mathematics, mechanics and structures modules from the first and second years (CE 102, CE 103, CE 104, CE 201, CE 206 and CE 207). This module is essential for those planning to take the fourth year electives: Steel Structures and Design (CE 401), Structural Dynamics (CE 402), Nonlinear Structural Mechanics (CE 403) and Earthquake Engineering (CE 413).

SYLLABUS

The module is divided up into three distinct blocks and the material covered is given with the approximate timescale:

Stability (MAW: 10 *Lectures + 4 Tutorials)*:

1. Energy methods of structural analysis and geometric nonlinearities.
2. Single degree of freedom systems: buckling, bifurcation and limit points.
3. Ideal and real column behaviour (development of Second year project).
4. Approximate techniques: Rayleigh and Timoshenko methods.
5. Lateral torsional buckling (LTB) in beams.
6. Introduction to instabilities in plated structures: local buckling under axial loads and shear.

Plasticity (CMT: *9 Lectures + 3 Tutorials)*:

7. Revision of plasticity in beams and section properties.
8. Introduction to composite sections.
9. Plastic collapse of statically indeterminate frames.
10. Upper and lower bound theorems of plasticity.
11. Combination of mechanisms and interaction diagrams.

Dynamics (KR: *6 Lectures + 3 Tutorials)*:

12. Dynamic loads and modelling: degrees of freedom, lumped mass, stiffness and flexibility.
13. Free vibrations of single degree of freedom elastic structures.
14. Viscous damping and logarithmic decrement.
15. Harmonically forced vibrations; resonance.
16. Introduction to support motion relevant for seismic loading.

Coursework

*Design, construction and testing of an aluminium girder (*MAW*: 15 Hours)*

This will reinforce several aspects of the module in a memorable way. The project is conducted in the second half of the Autumn term and the first half of the Spring term and will involve students working in groups. Two reports need to be submitted: a group report detailing the agreed design is submitted at the end of the Autumn term and an individual post-testing report is submitted in mid-February.

Assessment

One 3-hour examination at the beginning of the Summer term (64% of total mark) and coursework assignment reports (36% of total mark). The examination paper contains 2 sections: Section A contains 3 compulsory questions and Section B contains a further 4 questions of which 2 must be answered.

Recommended Textbooks/Reading:

BAZANT and CEDOLIN, Stability of Structures*, 1991 (Dover)* covers the entire Stability portion.

COATES, COUTIE and KONG, Structural Analysis, *1998 (Chapman and Hall),* contains introductory material for the whole module.

CLOUGH and PENZIEN, Dynamics of Structures, *1993 (McGraw Hill)* covers the Dynamics portion.

Learning Outcomes

- appreciate various different structural scenarios particularly of structural failure;
- analyse single degree of freedom systems for free and forced vibrations and structural stability;
- analyse and design steel column members and analyse beams susceptible to lateral torsional buckling;
- appreciate the concept of local buckling in structural elements;
- evaluate plastic collapse loads for statically indeterminate frames