CE104 STRUCTURAL MECHANICS

Co-ordinator: Professor M N Pavlovic (Room 326), m.pavlovic@imperial.ac.uk

Lecturers:	Professor D A Nethercot (DAN) Professor M N Pavlovic (MNP) Professor D Lloyd Smith (DLS)
Structure:	30 hours of lectures and tutorials, supported by computer laboratory work
Links:	From CE103 Mechanics to CE206 Structural Mechanics

Aims

To introduce the fundamentals of structural mechanics, and the behaviour of the main types of structural members and configurations (beams, pin-jointed bars and simple frames), as well as their use in buildings, bridges and off-shore structures.

SYLLABUS

The key idea of internal forces in structures will be explored in some depth through use of free-body diagrams.

REAL STRUCTURES AND MODELLING FOR ANALYSIS. Actual structures and appraisal of how they are intended to support design loads. (1 Lecture) (DLS)

PIN-JOINTED TRUSSES.

INTRODUCTORY CONCEPTS. Members, joints and supports. Loads and reactions. Equilibrium of a pin-jointed member, axial force. (1 Lecture) (DLS)

INTERNAL FORCES. Equilibrium of a joint, graphical representation and equations of equilibrium. Method of Sections. (3 Lectures) (DLS)

EQUILIBRIUM EQUATIONS. Computer solution of equilibrium equations for whole truss. Complex trusses. Static indeterminacy and mechanisms. (1 Lecture) (DLS)

DEFLECTION OF ELASTIC CANTILEVER TRUSSES. Small displacement theory. Extension and 'swing' of a member. Representation of joint deflection by the Williot diagram. (2 Lectures) (DLS)

BEAMS AND SIMPLE FRAMES

INTRODUCTORY CONCEPTS. Bending as a means of supporting load. Supports and reactions. Types of beams and frames. Static indeterminacy and mechanisms. (1 Lecture) (RLV)

INTERNAL FORCES. Use of free-body diagrams for obtaining bending moment, shear force and twisting moment distributions in statically determinate beams and frames. Relation between shear force and bending moment. (3 Lectures) (RLV)

BENDING STRESS IN ELASTIC BEAMS. Bernoulli-Euler hypothesis. Distribution of strain and stress through cross-section. Neutral axis, first and second moments of area. Fundamental equations of engineering beam theory. Calculation of bending stress. (2 Lectures) (RLV)

DEFLECTION OF ELASTIC BEAMS. Small displacement theory. Deflection related to curvature, curvature related to bending moment, flexural rigidity. Macaulay's method of integrating the differential equation of the elastic curve. (3 Lectures) (RLV)
EFFECTS OF PLASTICITY IN BEAMS. Stress-strain relationship for ductile steel. Moment-curvature relationship for different cross-sectional shapes. Post-yield bending stress distribution, partial plasticity, full-plasticity, and calculation of plastic moment capacity. Simplification via the plastic hinge concept. Plastic hinge mechanisms of collapse. Calculation of the collapse load for simple beams. (4 Lectures) (DLS)

Coursework and Submission Dates
Introduction to the use of a structural analysis computer program, QSE, and use of the package to analyse simple trusses and beams. Submission of results of these exercises. Week 20.

Assessment
One 3-hour written examination at the end of session containing 6 questions. Rubric:"Answer five questions". Coursework as note above.

Recommended Textbooks/Reading
Montague, P. and Taylor, R., Structural engineering, McGraw-Hill, 1989.
Hulse, R. and Cain, J., Structural Mechanics, Palgrave, 2000
Palmer, A. C., Structural Mechanics, Oxford, 1979.

Learning Outcomes
- Students should be able to model and solve straightforward problems in structures, including simple trusses, beams and frames.
- They should be able to determine the internal forces in statically determinate structures, the stresses within simple elements and cross-sections, deflections in cantilever trusses and simple beams, and have acquired an appreciation of modern structural analysis software.
- They should appreciate the concepts of designing for strength and deformation limits.