2E4 SOLIDS AND STRUCTURES [5 credits]

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Module organisation
The module runs for the first half (12 weeks) of the academic year and comprises of three lectures and one tutorial per week plus two one-hour laboratories (total of 48 hours contact time).

Module description, aims and contribution to programme
The 2E4 module is divided into two sections: (a) Mechanics of Solids and (b) Structures. Much emphasis is placed in this module on solving practical problems. *Mechanics of Solids* aims to develop an understanding of the stresses and strains that develop in solid materials when they are subjected to different types of loading and to develop an understanding of the conditions at failure of such materials. *Structures* aims to introduce the fundamental concepts of structural mechanics.

Learning outcomes
Upon completion of this module, students will be able to:
1. Calculate section properties.
2. Calculate stress, deformation and strain responses of structural members under a system of applied loads.
3. Analyse structural systems to determine sectional forces and demonstrate an understanding of their influence on overall structural response.
4. Examine possibilities for alternate structural arrangements where the structure as detailed is insufficient.
5. Differentiate between various limit states in structural analysis.
6. Analyse bolted connections.
7. Demonstrate an ability to visualize, understand and appraise structural behaviour in statically determinate structures.

Module content
*Mechanics of Solids*
- Elastic Plastic Behaviour
  Stress, strain, elasticity and plasticity; one-dimensional stress–strain relationships; Young’s modulus of elasticity, shear modulus and Poisson’s ratio; two-dimensional elasticity; isotropic and homogeneous materials; ductile and brittle materials; transformation of stress and strain; properties of sections (A and I); axial, shear and bending distortions.

- Analysis of Structural Members
  Connection design in trusses; torsion of shafts; buckling of struts; lateral torsional buckling; factors of safety
**Structures**
- Statically determinate pin-jointed structures
  Analysis using joint-equilibrium, method of sections and by inspection; statical determinacy; deflection of trusses using principle of virtual work
- Analysis of Beams and Frames
  Axial, shear force and bending moment diagrams; equation of condition, load function equation, qualitative analysis for two-dimensional frames; analysis for bending stress; cover plate design; analysis for shear stress and torsional stress
- Beam Deformations
  Bending deflections using moment-curvature equation; Mohr’s moment area theorems; shear deformations, torsional deformations

**Teaching strategies**
The module is taught using a combination of lectures, laboratories and tutorials. Most material (notes, textbook, tutorials, examinations) is provided on the College network. Students work in tutorial and laboratory groups in solving problems thereby encouraging teamwork and cooperation whereas the research reports are carried out individually.

**Associated laboratory/project/tutorial programme**
- Beam bending (laboratory experiment and research report);
- Buckling of slender columns (laboratory experiment and research report);
- Tutorial assignments (1 - 10).

**Assessment**
Assessment is by means of a two-hour end-of-year written examination (80%), and continuous assessment (20%).

**Recommended textbooks**
*Strength of Materials*, Timoshenko
*Strength of Materials*, GH Ryder, Macmillan
*Mechanics of Materials*, EJ Hearn, Pergamon
*Mechanics of Material*, Gere and Timoshenko, Wadsorth
*Structures—or why things don’t fall down*, JE Gordon, Penguin
*Introduction to Structural Mechanics*, Reynolds, Kent and Lazenby
*Structural Mechanics*, Williams, Morgan and Durka

**Further information**
http://www.tcd.ie/civileng/Staff/Bidisha.Ghosh/
http://www.tcd.ie/civileng/Staff/Alan.OConnor/
http://www.tcd.ie/Engineering/undergraduate/baiyear2/2E4