CE7S02: S2 – Advanced Structural Analysis [5 credits]

Module Co-ordinator(s): Assoc. Prof. Dermot O’Dwyer (dwodwyer@tcd.ie)

Module organisation
Department of Civil, Structural and Environmental Engineering

Module Pre-requisites
Module participants are expected have completed an undergraduate degree in engineering, maths-physics or similar. Students should have a good understanding of mechanics of solids, structural analysis using the stiffness method and should be familiar with differential equations.

Module description, aims and contribution to programme
The Advanced Structural Analysis Module can be taken as a Level 9 course in a single year for 5ECTS or as a Level 10 course over two years for a total of 10ECTS. The first year of the module is common to all students, in the second year Level 10 students who have completed the first year of the module will lead the work groups. This year the course will run from weeks 10 to 12 and there will be additional presentation sessions in January in the week prior to the beginning of 2nd term.

The aim of the course is to develop the ability of postgraduate Engineering students to develop and implement non-trivial analysis and modelling algorithms.

Learning outcomes
On successful completion of this module, students will be able to:
1. Identify the appropriate differential equations and boundary conditions for analysing a range of structural analysis and solid mechanics problems.
2. Implement the finite difference method to solve a range of continuum problems.
3. Implement a basic beam-element finite element analysis.
4. Implement a basic variational-based finite element analysis.
5. Implement time-stepping algorithms and modal analysis algorithms to analyse structural dynamics problems.
6. Detail the assumptions and limitations underlying their analyses and quantify the errors/check for convergence.

Module content
- Finite Difference analysis & solution of linear equations using relaxation methods
- Finite element analysis,
- Dynamic analysis of structures including modal analysis and time-stepping algorithms
- Variational calculus
- Convergence criteria and error bounding
Teaching strategies
The pedagogical approach taken in this course comprises problem based learning. Throughout the course the students will work in small groups tackling a range of engineering analysis problems. In some cases the analysis problems may come directly from the students’ research.
Each topic will be introduced with a number of lectures in which the key concepts are described briefly. The students will be given a series of purpose-written notes summarising the theory and will be directed to problem-specific texts. The students will be required to develop solutions to their assigned problems and deliver presentations on their experience of implementing their solutions.
The objective of the course is to ensure that students can implement the algorithms they develop, therefore the realisation of their solutions is a vital part of the course. Students will be encouraged to develop their solutions using basic programming resources such as excel and Matlab initially to minimise conflicts concerning specific programming languages.
The contact hours comprise 24 timetabled hours 12 hours of lectures, 6 hours of group tutorial troubleshooting sessions and 6 hours of presentations.

Assessment
Students will be assessed as either pass or fail based on their participation and performance in the analysis exercises and a written paper. The group exercises will form a significant component of the assessment.

Required textbook
In addition to a series of purpose written notes that will be used to support the course the following standard texts are recommended reading:

Further information
School of Engineering weblink.