Module Code	CE7S02
Module Name	Advanced Computation for Structures
ECTS Weighting[1]	5 ECTS
Semester taught	Semester 1
Module Coordinator/s	Module Coordinator: Assoc. Prof. Dermot O'Dwyer (dwodwyer@tcd.ie)
Module Learning Outcomes with reference to the Graduate Attributes and how they are developed in discipline	On successful completion of this module, students should be able to: LO1. Identify the appropriate differential equations and boundary conditions for analysing a range of structural analysis and solid mechanics problems. LO2. Implement the finite difference method to solve a range of continuum problems. LO3. Implement a basic beam-element finite element analysis. LO4. Implement a linear programming optimisation. LO5. Implement time-stepping algorithms and modal analysis algorithms to analyse structural dynamics problems. L06. Detail the assumptions and limitations underlying their analyses and quantify the errors/check for convergence. **Graduate Attributes: levels of attainment** To act responsibly - Enhanced To think independently - Enhanced To develop continuously - Enhanced To communicate effectively - Enhanced
Module Content	The aim of the Advanced Computation for Structures module is to enable students to develop and implement non-trivial analysis and modelling algorithms, specifically: ○ Finite Difference analysis and solution of linear equations using relaxation methods. ○ Finite element analysis; ○ Dynamic analysis of structures including modal analysis and time-stepping algorithms ○ Mathematical programming ○ Convergence criteria and error bounding

[1] TEP Glossary

	Although these analysis methods are typically applied to structural engineering problems, they are also widely used in other areas of civil engineering. Students who are following other streams in the MSc are welcome on the course and where possible these students are facilitated in solving numerical problems from their own disciplines. The Advanced computation for structures can be taken as a Level 9 course in a single year for 5 credits or as a Level 10 course over two years for the total of 10 credits. 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 group work and tackle more advanced analyses. The module runs from weeks 1 to 12 in the first semester.
Teaching and Learning Methods	The pedagogical approach taken in this course comprises problem-based learning. Throughout the course the students will work in small groups (or individually) 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 Python or any other suitable programming language.

Assessment Details[2]
Please include the following:
- **Assessment Component**
- **Assessment description**
- **Learning Outcome(s) addressed**
- **% of total**
- **Assessment due date**

Assessment Component	Assessment Description	LO Addressed	% of total	Week due
	Examination [3 hours]		40%	
	Continuous Assessment		60%	

[2] TEP Guidelines on Workload and Assessment

Reassessment Requirements **Must pass both the CA and Exam separately**	
Contact Hours and Indicative Student Workload[2]	**Contact hours:** The contact hours comprise 24 timetabled hours, 12 hours lectures, 6 hours of group tutorial troubleshooting sessions and 6 hours of presentations. **Independent Study (preparation for course and review of materials):** **Independent Study (preparation for assessment, incl. completion of assessment):**
Recommended Reading List	In addition to a series of purpose written notes that will be used to support the course the following standard texts are recommended reading: 1. The finite element methods for engineers, K.H. Heubner and E.A. Thornton, Wiley Inter-science , 1982 2. Structural Analysis; A Unified Classical and Matrix Approach: Amin Ghali, Adam Neville, TG Brown: Spon, 1997 *3.* Theory of Vibration with Applications by William T. Thomson, Taylor and Francis *4.* Theory of Elasticity (McGraw-Hill Classic Textbook Reissue Series) by S. P. Timonshenko and J.N. Goodier 5. Numerical Methods for Engineers by Steven C. Chapra and Raymond P. Canale, McGraw-Hill
Module Pre-requisite	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 stiffness method and should be familiar with differential equations.
Module Co-requisite	Previous programming experience is useful but not essential
Module Website	All materials are available on Blackboard
Are other Schools/Departments involved in the delivery of this module? If yes, please provide details.	NO