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<tr><td>Course unit title:</td><td colspan="3">Matrix Methods for Structural Analysis</td></tr>
<tr><td>Course unit code:</td><td colspan="3">CE300</td></tr>
<tr><td>Type of course unit:</td><td colspan="3">Compulsory</td></tr>
<tr><td>Level of course unit:</td><td colspan="3">Bachelor (1st Cycle)</td></tr>
<tr><td>Year of study:</td><td colspan="3">3</td></tr>
<tr><td>Semester when the unit is delivered:</td><td colspan="3">5 (Fall)</td></tr>
<tr><td>Number of ECTS credits allocated :</td><td colspan="3">6</td></tr>
<tr><td>Name of lecturer(s):</td><td colspan="3">Dr. Petros Christou</td></tr>
<tr><td>Learning outcomes of the course unit:</td><td colspan="3">1. Present the concepts of stiffness methods, stiffness coefficients, transformation matrices, external load and structural modelling.
1. Apply the concepts of stiffness for the analysis of statically indeterminate linearly elastic structures.
2. Analyze models of beams and frames using the slope deflection method.
3. Generalize the formation of stiffness equations including the use of matrix notation and matrix algebra to systemize the computations of the stiffness method.
4. Compute the stiffness terms, formulate and develop the stiffness matrix of a real structure.
5. Analyze real structures using the stiffness method for the determination of displacements and stresses.
6. Create models of real structures for linearly elastic frame structures.
7. Justify the use of the direct stiffness method for the analysis of structural systems over other methods of analysis.</td></tr>
<tr><td>Mode of delivery:</td><td colspan="3">Face-to-face</td></tr>
<tr><td>Prerequisites:</td><td>CE110, AMAT181</td><td>Co-requisites:</td><td>None</td></tr>
<tr><td>Recommended optional program components:</td><td colspan="3"></td></tr>
<tr><td>Course contents:</td><td colspan="3"><u>Basic Concepts:</u> Use of linear algebra for the solution of linear equations. Introduction to displacement methods and differentiation from the force methods. Introduction to structural modelling including element behaviour loads and supports.

<u>Slope Deflection Method:</u> Present the concepts of the slope deflection method and identify the differences with the flexibility method. Show how to identify and sketch global degrees of freedom. Describe the methodology for the implementation of the slope deflection method. Develop the general slope deflection equations and also calculate the fixed end moments. Write equilibrium equations at joints and solve to calculate the global degrees of freedom. Based on the values of the degrees of freedom calculate element end moments, shears and eventually the reactions of the structure. Formulate the slope deflection y method in matrix form and emphasize on the importance of the displacement methods and their implementation in computer software.

<u>Stiffness by Definition:</u> Define dependent, independent displacements and rigid body motion. Define the structural degrees of freedom and explain their role in the analysis of structures. Setup the stiffness matrix, the externally applied load vector and the displacement vector for various structural configurations using equations of slope deflection. Define the “stiffness coefficient” and its physical meaning in structural analysis. Calculate the stiffness coefficients and setup the global stiffness matrix of various structural configurations using the equations of slope deflection. Present and discuss the properties of the global stiffness matrix and the physical meaning of each property as that is referred to the real structures.

<u>Direct Stiffness Method</u>: Present the conditions for the validity of any structural analysis method (equilibrium, compatibility, constitutive laws). Explain the element by element approach for the analysis of structures and present the sign convention.</td></tr>
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	Define element (local) coordinate system and structure (global) coordinate system. Setup the element information in the local system including the element stiffness matrix and the degrees of freedom. Define the "transformation matrix" and explain how it relates the local and the global coordinate systems. Draw the displaced shapes, and calculate the transformation matrix in one step, for different structural configurations. Use the element by element approach to setup the stiffness matrices with the use of the transformation matrix and solve the equations for the calculation of displacements and element forces. Present the solution strategy of structural analysis software (automated direct stiffness) and explain how to obtain the transformation matrix in two steps. Discuss the "location vector" and present its implementation in the structural analysis software programs. Analyze structures using the automated direct stiffness with the aid of MATLAB, MATHCAD or EXCEL. **Structural Modelling:** Present the concept of structural modelling and relate to real structures. Discuss the modelling of supports based on the physical construction. Present the load paths and explain the choice of elements for the analysis using the direct stiffness method. Create models and analyse them.
Recommended and/or required reading:	
Textbooks:	"Matrix Analysis of Structures", Aslam Kassimali, CL-Engineering; 1999.
References:	"Matrix Analysis of Structures", Robert E. Sennett, Waveland Pr Inc; 2000. "Structural Analysis: Using Structural and Matrix Methods", Jack C. McCormac, Wiley, 2006. "Computer Assisted Structural Analysis and Modelling", Marc Ira Hoit, Prentice Hall, 1995.
Planned learning activities and teaching methods:	The course will be presented through theoretical lectures in class. The lectures will present to the student the course content and allow for questions. Part of the material will be presented using visual aids. The aim is to familiarize the student with the different and faster pace of presentation and also allow the instructor to present related material (photographs etc.) that would otherwise be very difficult to do. The learning process will be enhanced with the requirement from the student to solve exercises. These include self evaluation exercises which will be solved in class. These exercises will not be graded. Exercises will also be given as homework (final project) which will be part of their assessment. Besides from the notes taken by students in class, all of the course material will be made available through the class website and also through the eLearning platform. Finally the instructor will be available to students during office hours or by appointment in order to provide any necessary tutoring.
Assessment methods and criteria:	• Course work: 50% • Final Exam: 50%
Language of instruction:	English
Work placement(s):	No