

COMPUTATIONAL METHODS

SCHEDULE OF LECTURES AND CLASSES - SUMMER SEMESTER 2023/2024

CIVIL ENGINEERING II YEAR

W.	LECTURES (1H/WEEK)	LAB EXERCISES (2H/WEEK)
1	Computer simulations in mechanics and engineering. Mathematical modelling.	Introduction to ROBOT package. Analysis of a beam.
2	Local and global formulation of BVPs. Weighted residual, Galerkin method, approximation.	Modelling of a truss in ROBOT. Solution of a beam (assign't 1).
3	Finite element method (FEM).	Equilibrium check for plane frame (exercise) - ROBOT.
4	FEM for frame structures.	Approximation using interpolation functions. FEM solution for a beam (assign't 1 cont'd) - MATLAB/OCTAVE.
5	FEM for frame structures - truss example.	FEM solution for a beam (assign't 1 cont'd).
6	FEM - truss example (cont'd).	FEM solution for a truss (assign't 2).
7	FEM formulation for 2D problems - stationary heat flow.	FEM solution for a truss (assign't 2 cont'd).
8	Overview of 1D/2D/3D elements. Conditions for solution convergence.	FEM solution for a frame. Solution of example test problems.
9	FEM for stationary heat flow - example.	FEM simulation of heat flow using ABAQUS (assign't 3).
10	FEM for 2D problems - statics of a panel.	FEM simulation of heat flow using CALFEM (assign't 3 cont'd).
11	FEM for plane stress statics - example.	FEM simulation of heat flow (assign't 3 cont'd).
12	Estimation of approximation error.	Computation of stresses in a panel using ROBOT (assign't 4).
13	FEM for different structures. Isoparametric elements.	Computation of stresses in a panel (assign't 4 cont'd).
14	Simulations of frame buckling using FEM.	Delivery of assignments. Solution of example test problems.

REQUIREMENTS AND GRADING

- In order to obtain a positive grade the student is obliged to pass two tests and deliver the reports on the exercise and the following 4 assignments:

exercise - equilibrium check for a frame computed using ROBOT,

assign't 1 - solution of a beam using ROBOT and a MATLAB/OCTAVE script,

assign't 2 - solution of a truss by hand (check using a MATLAB script) and using ROBOT,

assign't 3 - simulation of heat flow using ABAQUS and MATLAB/OCTAVE script,
assign't 4 - solution of two-dimensional statics problem using ROBOT.

The presence at lectures is strongly advised and at laboratory exercises compulsory. It is admitted that a student may be absent from a lab class maximum 3 times due to important reasons. If an assignment report is delivered with a delay, the grade will be lowered. Exercise as well as assignments 1 and 2 have to be delivered before test 1, assignment 3 before test 2. Assignment 4 must be delivered by the summer break.

- Test 1 will take place after class no. 8 and will cover lectures 1-6 and labs 1-8. Test 2 will take place after class no. 12 and will cover lectures 7-12 and labs 9-12. There will be one more opportunity to take each of the tests after the results are announced. For those who do not pass (one of) the two tests, additional resits will be held in the first half of September, but only for the students who have a positive grade for laboratory classes and scored at least 30% of points to be obtained in former tests 1 and 2. If a student does not pass the tests, laboratory exercises passed with grade 3.0 will have to be repeated.
- The grade recorded in student's index book is computed as:
 $0.51 * \text{lab grade} + 0.49 * \text{average grade from 2 tests}$.

TEACHERS

LECTURES: Prof. J. Pamin

CLASSES: Dr B. Weisło (coordinator)

RECOMMENDED (*) AND SUPPLEMENTARY READING

1. (*) P.-E. Austrell et al, *CALFEM - a finite element toolbox*, version 3.4, Structural Mechanics, LTH Sweden 2004.
2. Cz. Cichoń, W. Cecot, J. Krok, P. Pluciński, *Metody komputerowe w liniowej mechanice konstrukcji*, Skrypt PK, Kraków 2010.
3. (*) R.D. Cook, *Finite Element Method for Stress Analysis*, J. Wiley & Sons 1995.
4. (*) J. Fish and T. Belytschko, *A First Course in Finite Elements*, J. Wiley & Sons 2007.
5. (*) N. Ottosen and H. Petersson, *Introduction to the Finite Element Method*, Prentice Hall 1992.
6. M. Radwańska, *Metody komputerowe w wybranych zagadnieniach mechaniki konstrukcji*, Skrypt PK, Kraków 2004.
7. G. Rakowski, Z. Kacprzyk, *Metoda elementów skończonych w mechanice konstrukcji*, Wydanie 3, Oficyna Wydawnicza PW, Warszawa 2016.
8. A. Skrzat, *Modelowanie liniowych i nieliniowych problemów mechaniki ciała stałego i przepływow ciepła w programie ABAQUS*, Oficyna Wydawnicza PRz, Rzeszów, 2010.
9. (*) Learning materials available on e-learning Delta platform.
10. (*) www.cce.pk.edu.pl - instruction documents online.
11. (*) Online documentation of ABAQUS and ROBOT.