COMPUTATIONAL METHODS

SCHEDULE OF LECTURES AND CLASSES - SUMMER SEMESTER 2024/2025

CIVIL ENGINEERING II YEAR

W.	LECTURES (1H/WEEK)	LAB EXERCISES (2H/WEEK)
1	Computer simulations in mechanics	Introduction to ROBOT package. Solu-
	and enginnering. Mathematical mo-	tion of a frame.
	delling.	
2	Local and global formulation of	Equilibrium check for plane frame (exer-
	BVPs. Weighted residual, Galerkin	cise). Modelling of a truss in ROBOT.
	method, approximation.	
3	Finite element method (FEM).	Mechanics of a beam. Solution of a beam
		using FEM (assign't 1) - ROBOT.
4	FEM for frame structures.	FEM solution for a beam (assign't 1
		cont'd) - algorithm and python script.
5	FEM for frame structures - truss	FEM solution for a beam (assign't 1
	example.	cont'd).
6	FEM - truss example (cont'd).	FEM solution for a truss (assign't 2).
7	FEM formulation for 2D problems -	FEM solution for a truss (assign't 2
	stationary heat flow.	cont'd).
8	Overview of $1D/2D/3D$ elements.	FEM solution for a truss. Solution of
	Conditions for solution convergence.	example test problems.
9	FEM for stationary heat flow -	FEM simulation of heat flow (assign't 3)
	example.	- ABAQUS.
10	FEM for 2D problems - statics of a	FEM simulation of heat flow (assign't 3
	panel.	cont'd).
11	FEM for plane stress statics - exam-	FEM simulation of heat flow (assign't 3
	ple.	cont'd).
12	Estimation of approximation error.	Computation of stresses in a panel using
		ROBOT (assign't 4).
13	FEM for different structures. Isopa-	Computation of stresses in a panel (as-
	rametric elements.	sign't 4 cont'd).
14	Simulations of frame buckling using	Delivery of assignments. Solution of exam-
	FEM.	ple 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 python script, assign't 2 - solution of a truss by hand and using ROBOT,

assign't 3 - simulation of heat flow using ABAQUS,

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.
- The grade recorded in student's index book is computed as: 0.51 * lab grade + 0.49 * average grade from 2 tests.

TEACHERS

LECTURES: Prof. J. Pamin CLASSES: Dr B. Wcisło (coordinator)

RECOMMENDED (*) AND SUPPLEMENTARY READING

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