1. Numerical Modelling

GENERAL INFORMATION ABOUT THE COURSE		
Course coordinator	Vlado Topša, PhD, associate professor	
Course name	**Numerical Modelling**	
Study program	**Mechanical Engineering**	
Course status	Compulsory	
Year	1	
Semester	2	
Number of credits and teaching methods	ECTS student load coefficient	6
	Number of hours (lectures + seminars + exercises)	30 + 15 + 15

1. DESCRIPTION OF THE COURSE

1.1. Course objectives

Familiarizing students with numerical methods applied in mechanical engineering applications. Training students for solving some of the simplest problems in structural strength, vibration, thermodynamics and fluid mechanics using different numerical methods, developing computational skills using some of the commercial numerical program packages.

1.2. Course enrolment prerequisites *(if applicable)*

Listened to the courses Strength, Thermodynamics and Fluid Mechanics.

1.3. Expected course learning outcomes

1. Defining the fundamental laws of continuum mechanics and understanding differential, variational and integral forms.
2. Understanding the fundamental concepts and steps in numerical modelling (preprocessing, spatial and temporal discretisation, solving linear equation systems, postprocessing).
3. Understanding and applying the finite-difference method, finite-volume method and finite-element method.
4. Applying the suitable numerical method depending on the given problem (problems involving heat transmission, problems associated with the theory of elasticity, vibration, fluid dynamic problems).

1.4. Course content

1. Modelling continuum mechanics problems, fundamental laws of continuum mechanics
2. Presenting commercial computer packages for numerical modelling

3. Steps in modelling, creating geometric models, spatial and temporal discretisation
4. Initial and boundary conditions, solving equation systems, presenting results
5. Differential and variational formulations. Weighted residual methods: Galerkin method, least squares method
6. Rayleight-Ritz method, principle of virtual work
7. Finite-difference method, presenting derivation, description boundary conditions
8. Finite-volume method, steps in the finite-volume method (FVM)
9. Explicit and implicit methods of temporal discretisation
10. Formulating the finite-elements method
11. Finite-elements method: stick elements
12. Continuation: beam elements
13. Comparing numerical methods using examples: heat transfer, strength problems
14. Continuation: problems involving fluid and vibration mechanics
15. Critical overview of numerical methods, stability, convergence, efficiency, error estimation

1.5. Types of teaching	☒ Lectures ☒ Seminars and workshops ☒ Exercises ☐ Distance learning ☐ Field work	☒ Autonomous exercises ☐ Multimedia and network ☐ Laboratory ☐ Mentor assistance ☐ Other types
1.6. Comments	Classes take place in the classroom in the form of lectures and auditory exercises. Students autonomously and in teams solve particular tasks. The seminar paper is selected from a certain area of application and is specially evaluated.	

1.7. Student obligations *(attendance at classes, lectures, tutorials, seminars)*

- Attending lectures, seminars and exercises
- Active participation in classes, participating in teamwork
- Solving seminar tasks

1.8. Tracking student work (proportion of individual activities in terms of ECTS credits based on the total number of ECTS credits)

Class attendance	2	Class attendance	0.5	Seminar paper	1.5	Experimental work	
Written exam	1	Written exam	0.5	Essay		Research	0.5
Project		Project		Report		Practical work	
Online activity							

1.9. Grading and assessment of student work during the semester and for the final exam *(interim exam, written exam, oral exam)*

Attending classes and activities in classes 10%, quality of drafting seminars 30%, written exams 30% and oral exam 30%

1.10. **Mandatory literature** (relevant at the time of submitting the proposed study program)
• Sorić, J.: Uvod u numeričke metode u strojarstvu, FSB, Zagreb, 2009. • Sorić, J.: Metoda konačnih elemenata, Golden marketing, Zagreb, 2004.
1.11. Supplementary literature (relevant at the time of submitting the proposed study program
• Zienkiewicz, O.C. and Taylor, R.L.: The Finite Element Method: Volume 1 The Basis, 5th Edition, Butterworth-Heinemann, Oxford, 2000 • S.V. Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Co., New York,1980. • Schaefer, M.: Numerik im Maschinenbau, Springer, Berlin 1998. • Marshal, D.: Finite Differenzen und Elemente, Springer, Berlin 1989.
1.12. Manner of tracking quality to ensure the acquisition of exit knowledge, skills and competences
Through the established quality assurance system at the university, student survey.

2. COMBINING THE LEARNING OUTCOMES, TEACHING METHODS AND ASSESSMENT OF THE LEARNING OUTCOMES

2.1. Class participation	*2.2. Student participation*	*2.3. Learning outcome*	*2.4. Assessment method*
Lectures and exercises	Actively following lectures and exercises, participating in discussions	1-3	Regularly attending classes (0-10%) and Final exam – written (0-30%) Final exam – oral (0-30%)
Seminar paper	Writing the seminar paper in accordance with instructions for work, applying principles which are presented and commented at lectures. Presenting the seminar paper and acquired competences relating to the course before students and the teacher.		