Countries	Institutions	Common Module	ECTS
Romania **Poland** **Greece** **France** **Bulgaria**	Military Technical Academy "Ferdinand I" Military University of Technology Hellenic Air Force Academy French Air Force Academy "Vasil Levski" National Military University	**Computer Aided Desing and Numerical Analysis** *European Common Technical Semester for Defence and Security*	**3.0**

Service	**Minimum Qualification of Instructors**
ALL	• **Officers or civilian Lecturers:** ○ English: Common European Framework of Reference for Languages (CEFR) Level B2 or min. NATO STANAG 6001 Level 3. ○ Expertise on relevant topics. ○ Relevant academic publications.
Language **English**	

Prerequisites for international participants

- English: Common European Framework of Reference for Languages (CEFR) Level B1 or NATO STANAG Level 2.
- At least 1 year of national (military) higher education.
- Basic knowledge on technical systems for security and defence

Goal of the Module

- The main goal of the subject is to provide knowledge in the field of implementation of Computer-Aided Design (CAD) and Computer-Aided Engineering (CEA) systems in the engineering practice. Currently used in industry approaches in solving engineering problems related to designing and evaluation of mechanical objects will be presented.
- Students will be familiar with the possibility of application of advanced 3D modelling techniques used to define the geometry of objects described by free form surfaces. Implementation of devices like 3D scanners and CT in the designing process will be discussed.
- Students will be introduced to the use of strength analysis used in the evaluation of designed objects. Fundamentals of preparation of Finite Elements Models, the definition of initial-boundary conditions, interpretation of obtained results of strength analysis will be discussed.

Learning outcomes		
	Know-ledge	• Fundamentals of the designing process, Feature-based and Boolean algebra modelling techniques, free-form surface modelling techniques, fundamentals of technical drawings, application of reverse engineering, • Finite Elements Analysis, strength analysis of mechanical objects, multibody analysis, kinematic and dynamic motion studies, parametric and topology optimisation.
	Skills	• Students will be able to design of various mechanical objects with the use of 3D CAD system (SolidWorks). • Defining complex objects and mechanisms based on the 3D CAD assemblies (SolidWorks). • Students will be able to operate with 3D scanner, use the collected digital data from 3D measurements and will get skills in the frame of 3D freeform surface modeling process. • Students will be able to conduct engineering strength analysis (Solid Works or Ansys Workbench). • Students will be able to evaluate the correctness of mechanism operating based on the results of motion studies (SolidWorks or MSC.ADAMS).

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	Compe-tences	• Students will be familiar with the designing process with the use of CAD systems. Students will know how to use CAD systems in designing process of various mechanical objects with different geometrical requirements. • Students will know how to implement the 3D scanner, CT as well as reverse engineering in the engineering practice. • Students will be able to conduct a strength evaluation of designed objects with the use of CAE tools. • Students will know how to verify the operational correctness of complex mechanisms, conduct motion studies.

Verification of learning outcomes:

- **Observation**: Throughout the Module students will meet with the systems applications and they will discuss the given topics in the plenary and present teamwork results. During these work students will be evaluated to verify their competences.
- **Project**: Group project and its defence and final examination.
- **Test**: Final examination at the end of the module.

Module details

Main Topic	Recom-mended WH	Details
Characterisation of Computer Aided Design (CAD) systems, classification, main functionalities and range of their application	**6**	Characterisation of Computer Aided Design (CAD) systems, classification, main functionalities and range of their application. (Lec.: 2h; Applications.: 4h) *Application of feature based and Boolean algebra functions, familiarisation with various commends used during 3D modelling process, application of geometrical and dimensional relations, creating of mechanical parts 3D models with different geometrical features, definition of assemblies 3D models, preparation of technical drawing based on 3D models.* • **Applications**: 1. Modeling of 3D parts and assemblies definition in CAD SolidWorks system 2. Advanced tools available in a 3D parts modelling process
Advanced methods of 3D modeling process with the use of Reverse Engineering	**6**	Advanced methods of 3D design with the use of Reverse Engineering (Lec.: 2h; Applications.: 4h) *Characterisation of various surface modelling techniques, free-form design, application of 3D scanners and CT, functionalities of reverse engineering software, characterisation of the geometrical quality control process.* • **Applications**: 1. Practical application of 3D scanner and reverse engineering in a 3D modelling process
Characterisation of available CAD tools dedicated to specific design applications	**6**	Characterisation of CAD tools dedicated to specific design applications (Lec.: 2h; Applications.: 4h) • **Applications**: 1. Design process of weldmetal and sheetmetal objects in SolidWorks CAD system 2. How to design objects made from plastics? Design process of mold tools

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Characterisation of Computer Aided Engineering (CAE) systems	**6**	Characterisation of Computer Aided Engineering (CAE) systems, classification, main functionalities and range of their application (Lec:2h, Ex:4h) • **Applications**: 1. Quick verification of engineering project correctness in SolidWorks system (4h)
Introduction to Finite Element Analysis (FEA)	**6**	Introduction to Finite Element Analysis, characterisation of implicite and explicite numerical solving procedure, definition of initial-boundary condition, preparation of Finite Elements models, application of various FE elements, (Lec.: 2h; Applications.: 4h) • **Applications**: 1. Introduction to Ansys Workbench, various approaches of definition the FE models (4h)
Application of Finite Element Analysis in engineering practice	6	Characterisation of mechanical strength analysis (under quasi-static, dynamic loading conditions), thermal analysis, introduction to optimisation (parametric and topology) studies. (Lec.: 2h; Applications.: 4h) • **Applications**: 1. Mechanical strength analysis in Ansys Workbench 2. Introduction to parametric and topology mechanical optimisation
Rigid body motion analysis with the use of CAE systems	6	Introduction to Multi Body Analysis (MBA), practical application of CAE software in motion studies, Degrees of Freedom definition in models, geometrical relations, kinematic and dynamic analysis, parametric optimisation. (Lec.: 2h; Applications.: 4h) • **Applications**: 1. Introduction to rigid Multi Body Analysis (2h) 2. Studies of mechanism correctness based on the results of motion analysis (4h)
Total WH	**42**	
Additional hours (WH) to increase the learning outcomes		
Self-Studies	33	• Enhancing knowledge by studying specific documents; • Individual preparation for the group project; • Team work for the group project; • Those hours comprise work of students in laboratories and exercises to improve skills and consolidate knowledge.
Total WH	**75**	

BIBLIOGRAPHY:

1. Jayanta Sarkar, Computer Aided Design a Conceptual Approach, CRC Press, 2017,
2. Lani Tran, Mastering Surface Modeling with SOLIDWORKS 202, Basic through Advanced Techniques, SDC Publications, 2021,
3. U. Rembold, R. Dillmann, Computer-Aided Design and Manufacturing: Methods and Tools, Springer, 2011
4. Jože DuhovnikIvan DemsarPrimož Drešar, Space Modeling with SolidWorks and NX, Springer, 2015,
5. R S Khurmi & N. Khurmi, A Textbook of Engineering Mechanics, S. Chand Publishing, 2019,
6. O. C. Zienkiewicz i K. Morgan, Finite Elements and Approximation, Dover Publications, 2006,
7. Pawel M. Kurowski, Finite Element Analysis for Design Engineers, SAE International, 2016,
8. Robert H. King, Finite Element Analysis with SOLIDWORKS Simulation, Cengage Learning, 2017,
9. Abhinandan Jain, Robot and Multibody Dynamics: Analysis and Algorithms, Springer, 2014

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10. Paramanand Vivekanand Nandihal, Ashish Mohan, Subir Kumar Saha, Dynamics of Rigid-Flexible Robots and Multibody Systems, Springer, 2021

List of Abbreviations:

B1, B2 ..... CEFR Levels

CEFR ..... Common European Framework of Reference for Languages

ECTS ..... European Credit Transfer and Accumulation System

CAD ..... Computer Aided Design

CAE ..... Computer Aided Engineering

CT ..... Computer Tomography

RE ..... Reverse Engineering

WH ..... Working Hour

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