STUDY MODULE DESCRIPTION FORM

Name of the module/subject **Modelling of mechanical systems**			Code **1010622221010640413**
Field of study **Mechanical Engineering**	Profile of study (general academic, practical) **(brak)**		Year /Semester **1 / 2**
Elective path/specialty **Internal Combustion Engines**	Subject offered in: **Polish**		Course (compulsory, elective) **obligatory**
Cycle of study: **Second-cycle studies**	Form of study (full-time,part-time) **full-time**		
No. of hours Lecture: **1** Classes: **2** Laboratory: **-** Project/seminars: **-**			No. of credits **3**
Status of the course in the study program (Basic, major, other) **(brak)**	(university-wide, from another field) **(brak)**		
Education areas and fields of science and art **technical sciences** **Technical sciences**			ECTS distribution (number and %) **3 100%** **3 100%**

Responsible for subject / lecturer:

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Responsible for subject / lecturer:

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Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basic knowledge of mathematics, materials science, mechanics, basics of machine design, theory of machines and mechanisms and strength of materials acquired during the first and second degree studies.
2	**Skills**	Basics of vector and tensor analysis, the ability to solve differential equations, the ability to solve simple problems of mechanics and strength of the materials, the ability to conduct the engineering calculations and components selection, the ability to design machines and devices, the ability to make a technical documentation in accordance with the principles of engineering drawing, the ability of using CAD software.
3	**Social competencies**	Students are creative and consistent in the implementation of the tasks has autonomy to solve problems, acquire and improve their knowledge and skills..

Assumptions and objectives of the course:

The objective of the course is learning students a new mathematical apparatus necessary in the process of modeling materials and machines (mechanisms), learning the basics of physical and mathematical modeling of construction materials, machinery and equipment, some physical processes, learning the methods of optimization and computer simulations of construction and technological processes, with focus on the practical application of these skills in the design process of machines and devices.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Has general knowledge about the principles and methods of constructing working machines, in particular the methods of functional and strength calculations, optimization of mathematical mechanical constructions and modeling of machine structures in 3D systems - [M2_W17]

2. He knows contemporary methods of computer graphics engineering and theoretical foundations of engineering calculations using the finite element method - [M2_W06]

3. He has broadened knowledge in the field of computer science, programming computers and programs for engineering calculations in the field of computer simulation of physical systems - [M2_W05]

4. Has basic knowledge in the field of mechanics of solids and discrete systems with many degrees of freedom, mathematical modeling of physical and mechanical systems based on the d'Alembert principle and Lagrange equation, mathematical description of materials using constitutive equations - [M2_W02]

Skills:

1. Can use a popular system for numerical calculations to program a simple simulation task of a system with a small number of degrees of freedom - [M2_U11]

2. Is able to perform an average complex design of the construction of a work machine or its assembly using modern CAD tools, including tools for spatial modeling of machines and calculations using the finite element method - [M2_U15]

3. s able to write a simple computer program using modern RAD environments in the language known to you for the design optimization calculations using the acquired elementary numerical methods - [M2_U12]

Social competencies:

1. Is ready to critically evaluate your knowledge and content you receive - [M2_K01]

2. Is ready to recognize the importance of knowledge in solving cognitive and practical problems and to consult experts in the event of difficulties in solving the problem - [M2_K02]

Assessment methods of study outcomes

An exam from the lectures on the last lecture in semester, which evaluates the knowledge of the theory and the ability to use it in practice. Passing the classes based on the individual project of the machine or device with using modelling in the design process, which is submitted at the latest at the last classes. During the classes the current understanding of the previously presented material is verified by solving the tasks on the blackboard by students.

Course description

Notes on modeling - a goal of modeling entities. The modeling process - stages of modeling scheme. Physical modelling - simplifying assumptions, the physical parameters, examples of physical models. Mathematical modelling - basics model, the size of tensor, coordinate systems, principles for the formulation of constitutive relationships, formulate and solve the equations of motion of mechanical systems. Mathematical models of construction materials - one-parameter models, complex models, some models nonclassical. Mechanical systems one and two-parameter - equations of motion, vibration, undamped and damped. Mathematical models of selected processes - electromechanical systems, hydrodynamical systems. The analogies between the worlds of physical. Mathematical modelling of machines and devices ? forward and reverse kinematics (Denavit-Hartenberg notation), modelling stresses in the constructional elements, derivation of dynamic alternative parametres. Structure of the simulation models, Finite Elements Method (FEM). Optimization of construction.

Basic bibliography:

1. Derski W., Ziemba S., Analiza modeli reologicznych, Wyd. PWN, Warszawa 1968.

2. Ostwald M.: Podstawy optymalizacji konstrukcji. Wyd. Politechniki. Poznańskiej 2005.

3. Wrotny L.T., Zadania z kinematyki i dynamiki maszyn technologicznych i robotów przemysłowych, Wyd. PW, Warszawa 1998.

4. Czemplik A., Modele dynamiki układów fizycznych dla inżynierów

5. Heimann B., Gerth W., Popp K., Mechatronika. Komponenty, metody, przykłady. PWN, Warszawa 2001.

6. Jezierski E., Dynamika robotów, WNT, Warszawa 2006.

7. Ostrowska-Maciejewska; Podstawy mechaniki ośrodków ciągłych, PWN, Warszawa 1982

8. R. H. Cannon jr.; Dynamika układów fizycznych, WNT, Warszawa 1973

9. Szturmowski B., Inżynierskie zastosowanie MES w problemach mechaniki ciała stałego na przykładzie programu ABAQUS, Wyd. Akademii Marynarki Wojennej, 2013

10. Skrzat A., Modelowanie liniowych i nieliniowych problemów mechaniki ciała stałego i przepływów ciepła w programie ANSYS Workbench/Abaqus, Wyd. Politechniki Rzeszowskiej, 2014

Additional bibliography:

1. Z. Parszewski; Drgania i dynamika maszyn, WNT, Warszawa 1982

2. R. Scanlan, R. Rosenbaum; Drgania i flatter samolotów, PWN, Warszawa 1964

3. W. Tarnowski; Modelowanie systemów, Wyd. Politechniki Koszalińskiej, Koszalin 2004

4. W. Flügge; Tensor analysis and continuum mechanics, Springer-Verlag, Berlin 1972

5. Bąk R., Burczyński T., Wytrzymałość materiałów z elementami ujęcia komputerowego, wyd. WNT, Warszawa 2013

6. Spong M., Vidyasagar M., Dynamika i sterowanie robotów, WNT, Warszawa 1997

Result of average student's workload

Activity	Time (working hours)

1. Participation in Lectures	15
2. Participation in Classes	30
3. Preparing to classes	5
4. Current application of the gained knowledge in the project	5
5. Making the project	10
6. Consultations	2
7. Preparing to pass lectures	4
8. Pass the exam	2
9. Pass the classes	2

Student's workload

Source of workload	hours	ECTS
Total workload	75	3
Contact hours	51	2
Practical activities	0	0