POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modelling of mechanical systems [S2MiBP1>MUM]

Course

Field of study
Mechanical and Automotive Engineering

Year/Semester
1/2

Area of study (specialization)
Heavy-duty Machines

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
30

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Basic knowledge of mathematics, materials science, mechanics, basics of machine design, theory of machines and mechanisms and strength of materials. 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. Students are creative and consistent in the implementation of the tasks has autonomy to solve problems, acquire and improve their knowledge and skills.

Course objective

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 and technological processes.

Course-related learning outcomes

Knowledge:
Has a basic knowledge of the mechanics of solids and discrete systems with many degrees of freedom, mathematical modeling of physical and mechanical systems based on d"Alembert"s principle and

Lagrange"s equations, mathematical description of materials using constitutive equations.
Has extended knowledge in the field of computer science, concerning computer programming and engineering calculation programs in the field of computer simulation of physical systems.
He knows the modern engineering methods of computer graphics and the theoretical basis of engineering calculations using the finite element method.
Has a general knowledge of the principles and methods of constructing working machines, in particular the methods of functional and strength calculations, mathematical optimization of mechanical structures and modeling of machine structures in 3D systems.

Skills:
Can use a popular numerical system to program a simple system simulation task with a small number of degrees of freedom.
Can write a simple computer program with the use of modern RAD environments in a language known to him for the optimization calculations of structures using learned elementary numerical methods.
Can perform a medium complex design of a working machine or its assembly using modern CAD tools, including tools for spatial modeling of machines and calculations using the finite element method.

Social competences:
He is ready to critically assess his knowledge and received content.
Is ready to recognize the importance of knowledge in solving cognitive and practical problems and to consult experts in case of difficulties in solving the problem on its own.
It is ready to fulfill social obligations, inspire and organize activities for the benefit of the social environment.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
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 passing test which covers accounting tasks related to material and machinery modelling. During the classes the current understanding of the previously presented material is verified by solving the tasks on the blackboard by students.

Programme content

Notes on modeling. Modeling process. Physical modeling. Mathematical modeling. Mathematical models of construction materials. Mechanical systems - equations of motion, undamped and damped vibrations. Construction of simulation models.

Course topics

Wykład: Uwagi o modelowaniu - cel, podmioty modelowania. Proces modelowania - etapy modelowania, schemat. Modelowanie fizyczne - założenia upraszczające, wielkości fizyczne, przykłady modeli fizycznych. Modelowanie matematyczne - podstawy modelowania, wielkości tensorowe, układy współrzędnych, zasady formułowania związków konstytutywnych, formułowanie i rozwiązywanie równań ruchu układów mechanicznych. Matematyczne modele materiałów konstrukcyjnych - modele jednoparametrowe, modele złożone, wybrane modele nieklasyczne. Układy mechaniczne jedno i dwuparametrowe - równania ruchu, drgania nietłumione i tłumione. Matematyczne modele wybranych procesów - układy elektromechaniczne i układy hydrodynamiczne. Analogie między środowiskami fizycznymi. Modelowanie matematyczne maszyn i urządzeń - kinematyka i dynamika prosta i odwrotna (notacja Denavita-Hartenberga), modelowanie stanu naprężenia w elementach konstrukcyjnych, wyznaczanie dynamicznych parametrów zastępczych. Budowa modeli symulacyjnych, metoda elementów skończonych (MES). Optymalizacja konstrukcji.
Ćwiczenia: Wyprowadzanie charakterystyki modeli reologicznych materiałów. Tensory naprężenia i odkształcenia.Modelowanie stanu naprężenia w elementach konstrukcyjnych. Dynamika układów mechanicznych – równania Lagrange’a II rodzaju. Wyznaczanie dynamicznych parametrów zastępczych. Notacja Denavita-Hartenberga – zadanie kinematyki prostej i odwrotnej.Budowa modelu symulacyjnego MES.Optymalizacja konstrukcji. Metoda oczkowa – analogie pomiędzy układami mechanicznymi i elektrycznymi.Modelowanie dynamiki elektromagnesu i silnika prądu stałego.

Teaching methods

Lecture: multimedia presentation and examples solved by the teacher. Tasks for individual or group solution.
Tutorials: multimedia presentation and examples solved by the teacher or by students on the board. Tasks to be solved during classes.

Bibliography

Basic
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

Additional
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

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00