COURSE DESCRIPTION CARD - SYLLABUS

Course name
Basics of machine design [S1Mech2>PKM1]

Course

Field of study
Mechatronics

Year/Semester
2/3

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other
0

Tutorials
0

Projects/seminars
15

Number of credit points

3,00

Coordinators

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Lecturers

Prerequisites

Knowledge of: technical drawing, technical mechanics, introduction to mechatronics, construction materials, mathematics, and physics. Skills: ability to sketch machine part concepts, simple mechanisms, determine the method of fixing and loading parts, and propose materials for machine components. Social competences: understanding the need to expand one's competencies, willingness to collaborate within a team.

Course objective

The aim of the course is to introduce the student to the fundamentals of machine design, focusing on the methodology of design of machines, the design of permanent and separable connections, flexible elements, and the basic issues related to machine parts: types and characteristic features.

Course-related learning outcomes

Knowledge:
The student knows the basic principles of design methodology in machine design, is familiar with the types of machine parts, and understands the types of permanent and separable joints.

Skills:
The student is able to propose a concept for machine parts.
The student can calculate and design permanent joints.
The student can generally name and characterize machine parts.
The student is able to select flexible elements.

Social competences:
The student understands the need for lifelong learning and can inspire and organise the learning process of others.
The student is able to collaborate and work in a group, taking on various roles.
The student can set priorities to achieve a task defined by themselves or others.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: written exam on the last lecture containing 3 theoretical questions and 2 practical tasks.
Duration: 90 minutes.
Assessment criteria: 2 points for each theoretical question, 3 points for each task, points are awarded with an accuracy of 0.5 points, a total of 12 points can be obtained.
Grading scale: below 50% - 2.0, from 50% - 3.0, from 60% - 3.5, from 70% - 4.0, from 80% - 4.5, from 90% - 5.0.
Laboratory: assessment is based on the verification of practical 3D modelling skills by independently recreating a given object and preparing its production documentation. The assessment takes place during the final laboratory session and lasts 90 minutes.
Assessment criteria: evaluatiuon of the accuracy of the developed 3D model and documentation (75% of the grade) and assesment of the methodological correctness in performing individual modelling stages (25% of the grade).
Grading scale: below 50% - 2.0, from 50% - 3.0, from 60% - 3.5, from 70% - 4.0, from 80% - 4.5, from 90% - 5.0.
Project: the final project must be completed according to the design data provided by the lecturer during the first session. It is carried out individually, with ongoing verification of progress.
Assessment criteria: the project is presented to the lecturer during the final session and submitted electronically (3D model + assembly drawing + rendered graphic). The final grade is based on progress during the sessions (25% of the grade) and the substantive quality of the completed project (75% of the grade).

Programme content

Methodology of machine design, machine parts, separable and permanent connections, flexible elements.

Course topics

Lecture 1 (2) - Methodology of machine design
General and detailed design principles, stages of machine part design.
Lecture 2 (2) - Tolerances and fits in machine design
Principles of using tolerances and fits in machine design, typical cases and examples.
Lecture 3 (2) - Machine parts
Identification of machine part types, their features, and characteristics.
Lecture 4 (2) - Separable connections
Characteristics and design of screw connections.
Lecture 5 (2) - Separable connections
Characteristics and design of key, spline, pin, and spigot connections.
Lecture 6 (2) - Permanent connections
Characteristics and design of welded, pressure welded, soldered, glued, and riveted joints.
Lecture 7 (2) - Flexible elements
Characteristics, calculations, and selection of flexible elements: springs and elastomers.
Lecture 8 (1) - Assessment
Laboratories:
Laboratory 1 (2) - Part modelling in SolidWorks - basic methods

Modelling of a fork mounting (simple extrusion, filleting, hole, pattern), modelling of axisymmetric parts (adding by rotation, cutting by rotation, chamfering, threading).
Laboratory 2 (2) - Part modelling in SolidWorks - advanced methods
Modelling of a body-type element, modelling of threads and coil springs.
Laboratory 3 (2) - Frame modelling in SolidWorks
Modelling of welded frames, modelling of bent connectors.
Laboratory 4 (2) - Assembly modelling in SolidWorks
Assembly of elements with nontypical geometries (e.g. coil spring), pattern and mirror in assembly (inserting connectors), assembly enabling motion animation.
Laboratory 5 (2) - Preparation of technical documentation based on the 3D model
Exploded view in assembly, machine assembly documentation.
Laboratory 6 (2) - Simulation of mechanism and machine operation
Motion simulation of the mechanism, simple strength simulation.
Laboratory 7 (1) - Preparing a file for 3D printing
Preparing the file for 3D printing on the basis of the 3D model of a selected part from previous classes.
Laboratory 8 (2) - Reverse engineering in 3D modelling - final assessment
Independently recreate the given object and prepare its production documentation.
Projects:
Project 1 (2) - Discussion and distribution of projects, modelling of frame structures in Autodesk Inventor
Establishing input data and form of the final project (design of a simple wheeled vehicle with electric drive), discussing the stages of the project.
Inserting standardised profiles and generating profiles with custom-defined cross-sections, processing profiles to obtain frame structures with specific geometries, generating technical documentation for such assemblies.
Project 2 (2) - Sheet metal modelling in Autodesk Inventor
Generating sheet metal parts, using tools for sheet metal processing to obtain spatial forms (e.g. bending, extrusion, cutting, etc.), generating flat patterns, generating technical documentation for such parts.
Project 3 (2) - Modelling of permanent joints in Autodesk Inventor
Generating welded connections in machine parts and profiles; tools for calculating and presenting them in technical documentation.
Project 4 (2) - Modelling of separable connections and springs in Autodesk Inventor
Generating connections: threaded, key, spline, pin, and springs; built-in tools for calculating them.
Project 5 (2) - Modelling of drive system elements in Autodesk Inventor
Generating: belt drives, bearings, and shafts, as well as tools for carrying out structural calculations for these elements.
Project 6 (2) - Documenting work on 3D models in Autodesk Inventor
Rendering graphics and animations using the Inventor Studio add-in.
Project 7 (2) - Final project consultation
Project 8 (1) - Final project assessment

Teaching methods

Lecture: Lecture with multimedia presentation, using the case study method - analysis of solutions to real construction problems.
Laboratory: Workshop methods of practical laboratory classes at computer stations.
Project: Workshop methods for practical construction classes. Project methods.

Bibliography

Basic:
1. Zbigniew Osiński, Podstawy Konstrukcji Maszyn, Wydawnictwo Naukowe PWN, 2017.
2. Antoni Skoć, Jakub Pałek, Podstawy Konstrukcji Maszyn, Tom 1, Wydawnictwo Naukowe PWN.
3. Marek Dietrich, Podstawy Konstrukcji Maszyn, Tom 1, Wydawnictwo Naukowe PWN, 2017.
4. Stasiak Fabian, Zbiór ćwiczeń: Autodesk Inventor 2020 - kurs podstawowy, EkspertBooks, 2019.
5. Stasiak Fabian, Zbiór ćwiczeń: Autodesk Inventor 2020 - kurs zaawanowany, EkspertBooks, 2020.
6. Jaskulski Andrzej, Autodesk Inventor Professional 2024PL/2024+/Fusion 360: metodyka efektywnego projektowania, Helion, 2023.
7. Krawiec P. red., Grafika komputerowa dla mechaników, Wydawnictwo PP, 2020.

Additional:
Leonid Kurmaz, Projektowanie węzłów i części maszyn, Wydaw. Politechniki Świętokrzyskiej, Kielce 2007.

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