COURSE DESCRIPTION CARD - SYLLABUS

Course name
Construction of multirotor frames [S1Lot2-BSP>BRM]

Course

Field of study
Aviation

Year/Semester
3/5

Area of study (specialization)
Unmanned Aerial Vehicles

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
0

Other
0

Tutorials
15

Projects/seminars
30

Number of credit points

5,00

Coordinators

dr hab. inż. Krzysztof Talaśka prof. PP
krzysztof.talaska@put.poznan.pl

Lecturers

Prerequisites

Knowledge: Basic knowledge of mathematics, materials science, mechanics, basics of construction machines, theory of machines and mechanisms, strength of materials. Skills: Ability to independently formulate a technical problem and prepare a record construction in accordance with the principles of technical drawing, calculation of the strength of machine elements, shaping the design features of aircraft components. Social competences: Understanding the need to expand one's competences, readiness to starting cooperation within a team.

Course objective

Getting to know the structure, properties and design features of multirotor frames. The methodology of designing multirotor frames presented in the course will be practiced practically during classes and during the implementation of individual projects.

Course-related learning outcomes

Knowledge:
1. Has structured, theoretically based general knowledge in the field of technology and various means of air transport, about the life cycle of means of transport, both hardware and software, and in particular about the

key processes occurring in them [L1_W02]
2. Has structured, theoretically based general knowledge covering key issues
in the field of technical thermodynamics, fluid mechanics, in particular aerodynamics [L1_W04]
3. Has structured, theoretically based knowledge in the field of engineering graphics and machine design:
technical drawing, object projection, basic principles of engineering graphics,
application of CAD (Computer Aided Design) computer graphic programs in the design
of machines

Skills:
1. Is able to obtain information from various sources, including literature and databases, both in Polish and English, integrate it properly, interpret and critically evaluate it, draw conclusions, and comprehensively justify the opinions formulated by him/her [L_U01]
2. Is able to properly plan and perform experiments, including measurements and computer simulations, interpret the obtained results, and correctly draw conclusions from them [L_U03]
3. Is able to formulate and solve tasks related to civil aviation, apply appropriate

Social competences:
1. Understands that in technology, knowledge and skills become outdated very quickly [L_K01]
2. Is aware of the importance of knowledge in solving engineering problems and knows examples and understands the causes of malfunctioning engineering projects that have led to serious
financial, social losses or serious loss of health or even life [L_K02]
3. Is able to think and act in an entrepreneurial manner, including finding commercial applications for the system being created, taking into account not only the business benefits but also the social benefits
of the conducted activity [L_K03]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lecture: Written assessment of the lecture containing several open theoretical questions. Duration:
90 minutes.
Assessment criteria: 1 point is awarded for each task, points are awarded
with an accuracy of 0.25 points, a total of 5 points can be obtained.
Rating scale: below 51% - 2.0, from 51% - 3.0, from 60% - 3.5, from 70% - 4.0, from 80% - 4.5, from 90% - 5.0.
Exercises: Written assessment of exercises containing 2-3 accounting or design tasks
last classes. Duration: 90 minutes.
Assessment criteria: 1 point is awarded for each task, points are awarded
with an accuracy of 0.25 points, a total of 2-3 points can be obtained.
Rating scale: below 51% - 2.0, from 51% - 3.0, from 60% - 3.5, from 70% - 4.0, from 80% - 4.5, from 90% - 5.0.
Projects: Assessment in the form of verification of practical skills in designing multirotor frames.
Each student completes an individual project based on established output data. Pass
consists in defending the completed project.
Assessment criteria: the correctness of the project preparation and preparation of technical documentation is assessed. There is a maximum of 1 point to be gained, points are awarded with an accuracy of 0.1 points.
Rating scale: below 51% - 2.0, from 51% - 3.0, from 60% - 3.5, from 70% - 4.0, from 80% - 4.5, from 90% - 5.0.

Programme content

Lectures:
Construction and design features of multirotor frames, materials used for multirotor frames, methodology for designing multirotor frames, CAD tools, prototyping possibilities.
Exercises:
Calculations for determining the design features of multirotor frames.
Projects:
Multirotor frame design.

Course topics

Lectures:
Lecture 1 - Construction, design features of multirotor frames
Presentation of the structure and design features of multirotor frames divided into size classes
and the number of arms, material and technological conditions of the frame.
Lecture 2 - Materials used for multirotor frames
Presentation of the advantages and disadvantages of using selected groups of materials for multirotor frames: alloys
light, plastics, composites.
Lecture 3 - Tools supporting the work of an engineer designing multirotor frames
Presentation of selected CAD tools with an indication of their advantages in the specificity of frame design multi-rotor aircraft (modeling + strength analyses: Inventor, Solid Works, Catia, Abaqus,
Ansys).
Lecture 4 - Methodology for designing multirotor frames, part 1
Indication of the stages of procedure when designing multirotor frames: output data, size class, number of engines, number of arms, arm arrangement.
Lecture 5 - Methodology for designing multirotor frames, part 2
Indication of the stages of procedure when designing multirotor frames: calculations of dimensions, weight, selection of materials, 3D modeling.
Lecture 6 - Methodology for designing multirotor frames, part 3
Indication of the stages of procedure when designing multirotor frames: strength and kinematic analyses, technical documentation.
Lecture 7 - Rapid prototyping
Preparation of design work results for rapid prototyping - 3D printing.
Lecture 8 - Assessment
Written assessment of the lecture containing several open theoretical questions
Exercises:
Exercises 1 - Calculations for the purpose of determining the design features of multirotor frames due to... dimensional class part 1.
Exercises 2 - Calculations for the purpose of determining the design features of multirotor frames due to... dimensional class part 2.
Exercises 3 - Calculations for the purpose of determining the design features of multirotor frames due to... number of arms: 2, 3, 4.
Exercises 4 - Calculations for the purpose of determining the design features of multirotor frames due to... number of arms: 6, 8.
Exercises 5 - Calculations for the purpose of determining the design features of multirotor frames due to... arm system: tricopter, quad +, quad X, quad H.
Exercises 6 - Calculations for the purpose of determining the design features of multirotor frames due to... arm arrangement: quad V, quad Y, hexa +, hexa X, hexa Y6
Exercises 7 - Calculations for the purpose of determining the design features of multirotor frames due to... arm arrangement: octo +, octo X, octo X8
Exercises 8 - Assessment
Written assessment of exercises containing 2-3 accounting or design tasks.
Projects:
Project 1 - 2 - Determination of guidelines and output data for individual projects.
Project 3 - 7 - Design calculations, 3D modeling, kinematic and strength analyses.
Project 8 - 14 - Prototyping.
Project 15 - Project defense.
Completing the project involves assessing the correctness of the project preparation and documentation technical.

Teaching methods

Lecture: Lecture with multimedia presentation.
Exercises: Computational exercises.
Project: Workshop methods for practical design and computer classes.

Bibliography

Basic:
1. Sarah Kreps, Drony: wprowadzenie, technologie, zastosowania, Wydawnictwo Naukowe PWN,

Warszawa, 2019
2. Wiktor Wyszywacz, Drony: budowa, loty, przepisy, Wydawnictwo Poligraf, Brzezia Łąka, 2016
3. Wiktor Wyszywacz, Drony : przepisy, budowa i eksploatacja BSP, loty, meteorologia, nawigacja, pilot, bezpieczeństwo, Wydawnictwo Poligraf, Brzezia Łąka, 2020
4. Lewitowicz J., Podstawy eksploatacji statków powietrznych. Tom I, ITWL, Warszawa 2001

Additional:
1. Pilecki S., Lotnictwo i kosmonautyka, WKŁ, Warszawa 1984,
2. Karpowicz J., Współczesne konstrukcje lotnicze, AON, Warszawa 2003.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,00
Classes requiring direct contact with the teacher	60	2,50
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	65	2,50