



## COURSE DESCRIPTION CARD - SYLLABUS

Course name

Simulation methods

### Course

Field of study

Aerospace Engineering

Area of study (specialization)

-

Level of study

First-cycle studies

Form of study

part-time

Year/Semester

2/4

Profile of study

general academic

Course offered in

polish

Requirements

compulsory

### Number of hours

Lecture

9

Laboratory classes

0

Other (e.g. online)

0

Tutorials

0

Projects/seminars

9

### Number of credit points

3

### Lecturers

Odpowiedzialny za przedmiot/wykładowca:

(B1)

dr hab. inż. **Piotr Sawicki**

email: piotr.sawicki@put.poznan.pl

tel. 61 665 22 49

Wydział Inżynierii Lądowej i Transportu

ul. Piotrowo 3, 61-138 Poznań

Odpowiedzialny za przedmiot/wykładowca

(B1):

dr inż. **Hanna Sawicka**

email: hanna.sawicka@put.poznan.pl

tel. 61 665 22 49

Wydział Inżynierii Lądowej i Transportu

ul. Piotrowo 3, 61-138 Poznań

Odpowiedzialny za przedmiot/wykładowca:

(B2)

mgr inż. **Kamila Przespolewska-Gdowik**

email: kamila.przespolewska-gdowik

@put.poznan.pl

tel. 61 665 23 36

Wydział Inżynierii Lądowej i Transportu

ul. Piotrowo 3, 61-138 Poznań

Odpowiedzialny za przedmiot/wykładowca:

(B3)

prof. dr hab. inż. **Ireneusz Pielecha**

email: ireneusz.pielecha@put.poznan.pl

tel. 61 224 45 02

Wydział Inżynierii Lądowej i Transportu

ul. Piotrowo 3, 61-138 Poznań



### Prerequisites

Knowledge: Basic knowledge of the construction of computer systems, basic knowledge of technical drawing

Skills: Ability to use computer systems, ability to draw a basic machine diagram using the principles of technical drawing

Social competences: Ability to work in a team

### Course objective

Gaining knowledge of methods and processes related to modeling and simulation

### Course-related learning outcomes

Knowledge

1. has extended knowledge necessary to understand the profile subjects as well as specialist knowledge about the construction, operation, air traffic management, safety systems, economic, social and environmental impact in the field of aviation and aerospace [K2A\_W01]
2. Has ordered, theoretically founded knowledge in the field of aircraft traffic analysis, calculations and simulations using specialized software or tools created independently [K2A\_W06]
3. Has knowledge of mathematics, including algebra, analysis, theory of differential equations, probability, analytical geometry [K2A\_W09]

Skills

1. Can use learned mathematical theories to create and analyze simple mathematical models of machines and their elements as well as simple technical systems. [K2A\_U26]
2. can draw a diagram and a simple machine element in accordance with the rules of technical drawing [K2A\_U23]
3. is able to assess the usefulness and use the tools integrated with packages for spatial modeling, and correctly interpret their results [K2A\_U17]

Social competences

1. understands the need for lifelong learning; can inspire and organize the learning process of other people [K2A\_K01]
2. Is ready to critically assess the possessed knowledge and received content, recognize the importance of knowledge in solving cognitive and practical problems and consult experts in the event of difficulties with solving the problem independently [K2A\_K02]
3. is aware of the social role of a technical university graduate, and especially understands the need to formulate and convey to the society, in particular through the mass media, information and opinions on the achievements of technology and other aspects of engineering activities; makes efforts to provide such information and opinions in a commonly understandable manner [K2A\_K08]



### Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

In the lecture part: written test summarizing lectures in the subject, in the form of a multiple-choice test.

In the design part: activity during classes and ongoing preparation for classes. Implementation of design tasks individually and in groups.

### Programme content

The lectures and project classes are closely thematically correlated. On the basis of the knowledge transferred during the lectures, problem tasks are solved during design classes and simulation experiments are conducted. The program content is divided into 3 thematic blocks:

#### Thematic block 1 (B1)

The content in B1 includes: Introduction to simulation methods, including: classification of simulation methods and models; the main components of the simulation model; methodology of solving decision problems with the use of simulation. Introduction to the ExtendSim simulation tool as an example of a stochastic, discrete and object-oriented simulation tool. Application of computer simulation in transport processes in aviation.

#### Thematic block 2 (B2)

The content of B2 includes: Application of simulations in aviation - examples of the use of simulations in aviation (simulations in aviation training, simulation studies on models of aviation objects, simulations in studies of the impact of aviation on the environment). The use of software to simulate the spread of harmful substances - CAMEO - simulation of air pollution dispersion in a selected area.

#### Thematic block 3 (B3)

The program content in B3 includes: Modeling of fuel injection and combustion with the use of AVL FIRE simulation software, including model meshing and visualization of simulation results. Modeling the emission of toxic exhaust gas components with the use of the nonlinear optimization module.

### Teaching methods

Informative (conventional) lecture (providing information in a structured way) - may be of a course (introductory) or monographic (specialist) character Project method (individual or team implementation of a large, multi-stage cognitive or practical task, the effect of which is the creation of a work)



## Bibliography

### B1 - Podstawowa

1. Law A.W., Kelton W.D., Simulation Modelling and Analysis. McGraw-Hill Education; 2000, ISBN 978-0071165372
2. Sawicki P., Metody symulacyjne (Cz.1/3). E-skrypt udostępniony na eKursy, Politechnika Poznańska, Poznań 2022.
3. Zeigler B.P., Teoria modelowania i symulacji. PWN Warszawa, 1984

### B1 - Uzupełniająca

1. ImagineThat, ExtendSim - QuickStart Guides. <https://extendsim.com/documentation>
2. Sawicki P., Sawicka H., Logistics process improvement using simulation and stochastic multiple criteria decision aiding. Procedia - Social and Behavioral Sciences, 2014, vol. 111, no. 5, 1142–1154.
3. Sawicki P., Sawicka H., Zastosowanie metod symulacji i stochastycznego wspomaganie decyzji do usprawnienia procesu logistycznego. W: A. Lichota, K. Majewska (red.), Wybrane zagadnienia logistyki stosowanej – Tom I, Wydawnictwa Akademii Górniczo-Hutniczej, Kraków 2013, s. 309-324.
4. Sawicki P., Sawicka H., Żak J., The simulation based solution of the fleet composition problem (FCP) in the fuel distribution network. Conference Proceedings of 23rd European Conference on Operational Research, Bonn, Germany, July 5–8, 2009, s. 74.

### B2 - Podstawowa

1. Astel A., Symulacja komputerowa jako narzędzie przewidywania skutków katastrof w przemyśle chemicznym. Problemy Ekologii, vol. 11, nr 3, str. 157-163, maj-czerwiec 2007.
2. Bartnik R., Grenda B., Galej P., Symulatory lotu oraz symulatory kontroli ruchu lotniczego w szkoleniu lotniczym, Wyd. Akademii Obrony Narodowej, Warszawa, 2014.
3. Leski J., Symulacja i symulatory, Wyd. MON, Warszawa, 1971.
4. Markiewicz M. T., Podstawy modelowania rozprzestrzeniania się zanieczyszczeń w powietrzu atmosferycznym, Oficyna Wydawnicza Politechniki Warszawskiej, 2004.

### B2 - Uzupełniająca

1. Allerton A., The impact of flight simulation in aerospace. Aeronautical Journal, vol. 114, pages 747-756, December 2010.
2. Krzymień W., Wstępne pomiary i symulacja bezrozbiegowego startu wiatrakowca. Mechanika w Lotnictwie - XVIII 2, 5 – 12, 2018.
3. Merkisz J., Nykaza A., Wykorzystanie symulatorów lotniczych FFS w procesie szkolenia pilotów akrobacyjnych. Autobusy : technika, eksploatacja, systemy transportowe, vol. 18, nr 6, str. 338-341, CD.
4. Nowakowski P., Wieczorek P., Nowoczesne modelowanie i optymalizacja przepustowości średniej wielkości portu lotniczego za pomocą oprogramowania WITNESS na przykładzie lotniska EPWA Warszawa im. F. Chopina. Przegląd Komunikacyjny, tom nr 12, str. 20-23, 2015.
5. Przespolewska-Gdowik K., Jasiński R., Analysis of the Nicolaus Copernicus Airport Activity in Terms of the Flight Operations Impact on Air Pollution. Energies, vol. 14(24), December 2021.



B3 - Podstawowa

1. Rychter T., Teodorczyk A., Modelowanie matematyczne roboczego cyklu silnika tłokowego. PWN, Warszawa 1980.
2. Sobieszcański M.: Modelowanie procesów zasilania w silnikach spalinowych. WKŁ, Warszawa 2000
3. Tarnowski W., Symulacja komputerowa procesów ciągłych. Wydawnictwo Uczelniane Wyższej Szkoły Inżynierskiej, Koszalin 1996
4. Zeigler B.P., Teoria modelowania i symulacji. PWN Warszawa, 1984.

B3 - Uzupełniająca

1. Instrukcja AVL FIRE, BOOST.
2. Pielecha I., Merkisz J., Optimizing the shape of a compression-ignition engine combustion chamber by using simulation tests. Polish Maritime Research 3 (103) 2019 Vol. 26; 138-146. DOI: 10.2478/pomr-2019-0054.
3. Sidorowicz M., Pielecha I., Simulative Assessment of Injectors Placement and the Thermodynamic Effects of Gasoline Injection and Combustion in a Direct Dual Injection System. SAE Technical Paper 2020-01-2054, 2020. <https://doi.org/10.4271/2020-01-2054>.

Sidorowicz M., Pielecha I. The injector location impact on the fuel combustion process in a direct gasoline injection system. Combustion Engines. 2018, 173(2), 19-29. DOI: 10.19206/CE-2018-204.

**Breakdown of average student's workload**

	Hours	ECTS
Total workload	75	3,0
Classes requiring direct contact with the teacher	20	1,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) <sup>1</sup>	55	2,0

<sup>1</sup> delete or add other activities as appropriate