



## Subject card

Subject name and code	Operational Research, PG_00055357						
Field of study	Informatics						
Date of commencement of studies	October 2022	Academic year of realisation of subject			2022/2023		
Education level	second-cycle studies	Subject group			Obligatory subject group in the field of study Subject group related to scientific research in the field of study		
Mode of study	Full-time studies	Mode of delivery			at the university		
Year of study	1	Language of instruction			English		
Semester of study	2	ECTS credits			3.0		
Learning profile	general academic profile	Assessment form			exam		
Conducting unit	Department of Algorithms and Systems Modelling -> Faculty of Electronics, Telecommunications and Informatics						
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Krzysztof Giaro					
	Teachers	prof. dr hab. inż. Krzysztof Giaro dr Paweł Obszarski mgr inż. Robert Ostrowski dr hab. inż. Jerzy Konorski					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	15.0	0.0	0.0	0.0	45
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM		
	Number of study hours	45	7.0	23.0	75		
Subject objectives	Student will be able to model and analyse simple queueing systems with a stochastic arrival proces.  Student will be able to apply and implement linear programming model.  Students will know basic techniques and methods for constructing timetables in basic models of deterministic task scheduling.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W01] Knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study.	The student is able to model a practical problem as a linear programming and determine its optimal solution.	[SW3] Assessment of knowledge contained in written work and projects
	[K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by:n-appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation,n-application of appropriate methods and toolsn	The student is able to apply mathematical methods to analyze the stochastic behavior of the queuing system with a given structure and parameters.	[SU1] Assessment of task fulfilment
	[K7_U05] can plan and conduct experiments related to the field of study, including computer simulations and measurements; interpret obtained results and draw conclusions	The student is able to analyze the basic characteristics of the queuing system according to the description.	[SU1] Assessment of task fulfilment
	[K7_U02] can perform tasks related to the field of study as well as formulate and solve problems applying recent knowledge of physics and other areas of science	The student knows the classifications of scheduling problems and algorithms for optimal scheduling.	[SU1] Assessment of task fulfilment
	[K7_U07] can apply advanced methods of process and function support, specific to the field of study	Student can match a stochastic model of a queuing system to its operational description.	[SU1] Assessment of task fulfilment

Subject contents	<p>Components, characteristics, and classification of queuing systems, the problem of stability.</p> <p>Construction of queuing processes: number of requests in system, unfinished work.</p> <p>System delays, Little's law, flow conservation equation for work-conserving systems.</p> <p>Statistical evaluation of service demand over a given observation period.</p> <p>Types of request arrival processes and service time distributions.</p> <p>Performance evaluation of computer and multiterminal systems based on mean offered load.</p> <p>Birth and death process and the M/M/1 system.</p> <p>Generalized birth and death processes and practical models of Markovian queuing systems: Erlang formula, impact of processors aggregation and buffer sharing, impatient requests.</p> <p>Definition of linear programming</p> <p>Applications of linear programming</p> <p>Simplex method</p> <p>Elements of integer programming</p> <p>3-field notation in task scheduling</p> <p>Project management</p> <p>Scheduling on parallel machines</p> <p>Scheduling on dedicated machines</p>												
Prerequisites and co-requisites	<p>Fundamentals of:</p> <ul style="list-style-type: none"> <li>- linear algebra,</li> <li>- theory of computing</li> <li>- discrete mathematics</li> <li>- probability and statistics</li> </ul>												
Assessment methods and criteria	<table border="1"> <thead> <tr> <th data-bbox="453 1785 794 1816">Subject passing criteria</th> <th data-bbox="799 1785 1141 1816">Passing threshold</th> <th data-bbox="1145 1785 1485 1816">Percentage of the final grade</th> </tr> </thead> <tbody> <tr> <td data-bbox="453 1823 794 1854">Reported solutions of exercises</td> <td data-bbox="799 1823 1141 1854">52.0%</td> <td data-bbox="1145 1823 1485 1854">34.0%</td> </tr> <tr> <td data-bbox="453 1861 794 1892">Final test, task scheduling</td> <td data-bbox="799 1861 1141 1892">52.0%</td> <td data-bbox="1145 1861 1485 1892">33.0%</td> </tr> <tr> <td data-bbox="453 1899 794 1930">Final test, linear programming</td> <td data-bbox="799 1899 1141 1930">52.0%</td> <td data-bbox="1145 1899 1485 1930">33.0%</td> </tr> </tbody> </table>	Subject passing criteria	Passing threshold	Percentage of the final grade	Reported solutions of exercises	52.0%	34.0%	Final test, task scheduling	52.0%	33.0%	Final test, linear programming	52.0%	33.0%
Subject passing criteria	Passing threshold	Percentage of the final grade											
Reported solutions of exercises	52.0%	34.0%											
Final test, task scheduling	52.0%	33.0%											
Final test, linear programming	52.0%	33.0%											

Recommended reading	Basic literature	<p>Brucker P., Scheduling Algorithms, Springer, 2007.</p> <p>L. Kleinrock: Queuing systems, vol. I, J. Wiley 1975</p> <p>Joti Lal Jain, W. Boehm, Sri Gopal Mohanty: A Course on Queuing Models, Chapman &amp; Hall 2006</p> <p>Taha H. A. Operations research : an introduction, Upper Saddle River: Person Prentice Hall, cop. 2007</p> <p>Hiller F. Liberman G, Introduction to operations research, McGraw-Hill, 2010.</p>
	Supplementary literature	<p>Judin D.E, Golsztejn E.G., Metody programowania liniowego, WNT 1964.</p> <p>Błazewicz J., Cellary W., Słowiński R., Węglarz J., Badania operacyjne dla informatyków, WNT, Warszawa, 1983.</p> <p>T. Czachórski: Modele kolejkowe w ocenie efektywności sieci i systemów komputerowych, Wyd. J. Skalmierski, Gliwice 1999</p> <p>B. Filipowicz: Modele stochastyczne w badaniach operacyjnych. Analiza i synteza systemów obsługi i sieci kolejkowych, WNT, Warszawa 1996</p> <p>W. Oniszczyk , Modele algorytmy kolejkowe i strategie obsługi w systemach komputerowych, Wyd. Politechniki Białostockiej 2009.</p>
	eResources addresses	Adresy na platformie eNauczenie:
Example issues/ example questions/ tasks being completed		
Work placement	Not applicable	