



## Subject card

Subject name and code	Operational Research, PG_00064506						
Field of study	Informatics						
Date of commencement of studies	October 2024		Academic year of realisation of subject		2024/2025		
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		dr hab. inż. Jerzy Konorski				
	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		9.0		21.0	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_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by: - appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation, - application of appropriate methods and tools	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_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_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 managment</p> <p>Scheduling on parallel machinges</p> <p>Scheduling on dedicated machines</p>		

Prerequisites and co-requisites	Fundamentals of:  - linear algebra,  - theory of computing  - discrete mathematics  - probability and statistics		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Final test, linear programming	52.0%	33.0%
	Final test, task scheduling	52.0%	33.0%
	Reported solutions of exercises	52.0%	34.0%
Recommended reading	Basic literature	Brucker P., Scheduling Algorithms, Springer, 2007.  L. Kleinrock: Queuing systems, vol. I, J. Wiley 1975  Joti Lal Jain, W. Boehm, Sri Gopal Mohanty: A Course on Queuing Models, Chapman & Hall 2006  Taha H. A. Operations research : an introduction, Upper Saddle River: Person Pretince Hall, cop. 2007  Hiller F. Liberman G, Introduction to operations research, McGraw-Hill, 2010.	
	Supplementary literature	Judin D.E, Golsztejn E.G., Metody programowania liniowego, WNT 1964.  Błażewicz J., Cellary W., Słowiński R., Węglarz J., Badania operacyjne dla informatyków, WNT, Warszawa, 1983.  T. Czachórski: Modele kolejkowe w ocenie efektywności sieci i systemów komputerowych, Wyd. J. Skalmierski, Gliwice 1999  B. Filipowicz: Modele stochastyczne w badaniach operacyjnych. Analiza i synteza systemów obsługi i sieci kolejkowych, WNT, Warszawa 1996  W. Oniszczyk , Modele algorytmy kolejkowe i strategie obsługi w systemach komputerowych, Wyd. Politechniki Białostockiej 2009.	
	eResources addresses	Adresy na platformie eNauczanie:	
Example issues/ example questions/ tasks being completed			
Work placement	Not applicable		

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