

## Subject card

Subject name and code	Modelling and Basics of Identification, PG_00058307								
Field of study	Automation, Robotics and Control Systems								
Date of commencement of studies	October 2023		Academic year of realisation of subject			2025/2026			
Education level	first-cycle studies		Subject group			Optional subject group 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	3		Language of instruction			Polish			
Semester of study	5		ECTS credits			4.0			
Learning profile	general academic profile		Assessment form			exam			
Conducting unit	Faculty of Electrical and Control Engineering								
Name and surname	Subject supervisor	ubject supervisor		dr hab. inż. Michał Grochowski					
of lecturer (lecturers)	Teachers								
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Projec	:t	Seminar	SUM	
	Number of study hours	30.0	0.0	30.0	0.0		0.0	60	
	E-learning hours inclu	learning hours included: 0.0							
Learning activity and number of study hours	Learning activity Participation in classes including plan				Self-study SUM		SUM		
	Number of study 60 hours			8.0		32.0		100	
Subject objectives	Presentation of modern methods of systems modeling and estimation of their parameters. Analytical, fuzzy and neural technology will be presented								
Learning outcomes	Course outcome		Subject outcome			Method of verification			
	[K6_U07] can build and analyze models of systems and systems in the field related to control systems and automation		eksperymenty, pomiary i symulacje komputerowe do oceny realizacji zadań z zakresu			[SU5] Assessment of ability to present the results of task [SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment			
	[K6_W07] has basic knowledge related to control and automation systems		- Students is able to build mathematical models of objects and dynamic processes - The student is able to study simulation and experimentally behaviour of of dynamic objects The student formulates and solves optimization problems with constraints.			[SW1] Assessment of factual knowledge			

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LECTURES	Subject contents							
demulsiplexing, sampling and extrapolating, AC and CAP processing. Selected middle of deterministic signals, Random signals, and identification: categories of the systems. Static and dynamic models (signals, Random et al.).  2. System theory in modelling-likes, Continuous and discrete sensets kinds of description. Linearization and controlling stations are proposed to the stationary and nonparametric models. Feromenological modelling, behavioral modelling and mixed modelling grey box modelling. Steps of modelling.  4. Phenomenological modelling reample of models - continuous and discrete, linear and nonlinear, stationary and nonstationary, deterministic and stochastic. Uncertainty modelling with usage suggests. Shortcure of fuzzy models—Hendrich Linear, Takegi Sugerno and Tskandom models.  5. Optimisation methods in identification: optimisation problems for parametric models. Criteria of optimisation o	,	LECTURES						
2. System theory in modelling and identification: categories of the systems. Static and synamic models. Linear and nonlinear models. Continuous and descrete models. Kinds of description. Linearization.  3. Parametric and nonparametric models. Peromenological modelling, behavioral modelling and makes and nonlinear stationary and nonstationary, deterministic and stochastic. Uncertainty modelling, Modelling with users a stationary and nonstationary, deterministic and stochastic. Uncertainty modelling. Modelling with users of fuzzy technology. Fuzzy reasoning systems. Students of fuzzy and nonstationary, deterministic and stochastic. Uncertainty modelling, Modelling with users of fuzzy technology. Fuzzy reasoning systems. Students of training of polimisation problems. Linear and nonlinear nades opinisation. Optimisation methods with and without constraints. Fundamentals of usage of the genetic algorithms.  5. Behavioural models and identification. System identification - problems. Linear and nonlinear models considering the parameters. Least squares method. Modelling with usage of neural technologies;  7. Modelling with usage of hybrid behaviours, example of advanced applications: neural - fuzzy models and identification - problems. Linear and nonlinear models considering the parameters. Least squares method. Modelling of phenomenological models based on principle rules of conservation - Designing of analogue diagrams.  1. Linearization.  2. Linearization. 2. Continuous systems - building of phenomenological models based on principle rules of conservation. Linearization. Linearization. Linearization. Modelling of discrete systems.  3. Selected optimisation problems. 3. Selected optimisation problems. 4. Fuzzy systems - definitions, properties, fuzzy reasoning.  5. Fuzzy systems - building of phenomenological models based on principle rules of conservation. Linearization. Modelling of discrete systems.  4. Modelling with usage of the final grade technological models based on principle rules of conservation. Lineariz		demultiplexing, sampling and extrapolating, A/C and C/A processing. Selected models of deterministic						
Continuous systems - building of phenomenological models based on principle rules of conservation - Designing of analogue diagrams.   Linearization.   Continuous/discrete signals - differences, ways of conversions.		signals. Random signals.  2. System theory in modelling and identification: categories of the systems. Static Linear and nonlinear models. Continuous and discrete models. Kinds of descrip 3. Parametric and nonparametric models. Fenomenological modelling, behavioral modelling grey box modelling. Steps of models - continuous and discrete, line stationary and nonstationary, deterministic and stochastic. Uncertainty modelling of fuzzy technology. Fuzzy reasoning systems. Structures of fuzzy models - Ma Sugeno and Tsukamoto models.  5. Optimisation methods In identification: optimisation problems for parametric mooptimisation. Optimisation methods with and without constraints. Fundamentals algorithms.  6. Behavioural models and identification: System identification - problems. Linear considering the parameters. Least squares method. Modelling with usage of ne training of neural models.  7. Modelling with usage of hybrid techniques; example of advanced applications:						
Linearization.								
Continuous systems - building of phenomenological models based on principle rules of conservation.		Designing of analogue diagram: Linearization. Continuous/discrete signals - di Discrete systems - definitions, a Selected optimisation problems	Designing of analogue diagrams.  Linearization.  Continuous/discrete signals - differences, ways of conversions.  Discrete systems - definitions, analysis.  Selected optimisation problems.					
Assessment methods and criteria    Subject passing criteria		<ul> <li>Continuous systems - building of phenomenological models based on principle rules of conservation.</li> <li>Linearization.</li> <li>Modelling of discrete systems.</li> <li>Model parameter estimations, Least squares method.</li> </ul>						
and criteria    Exam   60.0%   70.0%     Exercises   70.0%   15.0%     Laboratory   80.0%   15.0%     Recommended reading   Basic literature   1. Roffel, B., Betlem, B. (2006). Process Dynamic and Control. Modelling for Control and Prediction. John Wiley & Sons, Ltd. 2. Hangos, K.M., Cameron, I.T. (2001). Process Modelling and Model Analysis. Academic Press, Ltd. 3. Englezos, P., Kalogerakis, N. (2001). Appled Parameter Estimation for Chemical Engineers. Marcel Dekker, Inc. 4. Ljung, L. (1999). System Identification. Theory for the User. Prentice Hall. 5. Söderström, T., Stoica, P. (1997). Identyfikacja systemów. PWN, Warszawa 1997    Supplementary literature   1. Ljung, L., Glad, T. (1994). Modelling of Dynamic Systems. Prentice Hall. 2. Wellstead, P.E. (2000). Introduction to Physical System Modelling. Academic Press Ltd.    Example issues/ example questions/ tasks being completed   5. building a complex dynamic plant model in Matlab/Simulink software; dynamic model parameter estimation; process modeling using fuzzy sets; introduction to artificial neural networks.		There are no requirements						
and criteria    Exam   60.0%   70.0%     Exercises   70.0%   15.0%     Laboratory   80.0%   15.0%     Recommended reading   Basic literature   1. Roffel, B., Betlem, B. (2006). Process Dynamic and Control. Modelling for Control and Prediction. John Wiley & Sons, Ltd. 2. Hangos, K.M., Cameron, I.T. (2001). Process Modelling and Model Analysis. Academic Press, Ltd. 3. Englezos, P., Kalogerakis, N. (2001). Appled Parameter Estimation for Chemical Engineers. Marcel Dekker, Inc. 4. Ljung, L. (1999). System Identification. Theory for the User. Prentice Hall. 5. Söderström, T., Stoica, P. (1997). Identyfikacja systemów. PWN, Warszawa 1997    Supplementary literature   1. Ljung, L., Glad, T. (1994). Modelling of Dynamic Systems. Prentice Hall. 2. Wellstead, P.E. (2000). Introduction to Physical System Modelling. Academic Press Ltd.    Example issues/ example questions/ tasks being completed   5. building a complex dynamic plant model in Matlab/Simulink software; dynamic model parameter estimation; process modeling using fuzzy sets; introduction to artificial neural networks.	Assessment methods	Subject passing criteria	Passing threshold	Percentage of the final grade				
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Laboratory   80.0%   15.0%			70.0%	15.0%				
Modelling for Control and Prediction. John Wiley & Sons, Ltd.  2. Hangos,K.M., Cameron,I.T. (2001). Process Modelling and Model Analysis. Academic Press, Ltd.  3. Englezos, P., Kalogerakis, N. (2001). Appled Parameter Estimation for Chemical Engineers. Marcel Dekker, Inc.  4. Ljung, L. (1999). System Identification. Theory for the User. Prentice Hall.  5. Söderström, T., Stoica, P. (1997). Identyfikacja systemów. PWN, Warszawa 1997  Supplementary literature  1. Ljung, L., Glad, T. (1994). Modelling of Dynamic Systems. Prentice Hall.  2. Wellstead, P.E. (2000). Introduction to Physical System Modelling. Academic Press Ltd.  eResources addresses  Adresy na platformie eNauczanie:  * building a complex dynamic plant model in Matlab/Simulink software;  * dynamic model parameter estimation;  * process modeling using fuzzy sets;  * introduction to artificial neural networks.		Laboratory	80.0%	15.0%				
Example issues/ example questions/ tasks being completed  Hall.  2. Wellstead, P.E. (2000). Introduction to Physical System Modelling. Academic Press Ltd.  Adresy na platformie eNauczanie:  building a complex dynamic plant model in Matlab/Simulink software; dynamic model parameter estimation; process modeling using fuzzy sets; introduction to artificial neural networks.	Recommended reading	<u>'</u>	re 1. Roffel, B., Betlem, B. (2006). Process Dynamic and Control. Modelling for Control and Prediction. John Wiley & Sons, Ltd. 2. Hangos,K.M., Cameron,I.T. (2001). Process Modelling and Model Analysis. Academic Press, Ltd. 3. Englezos, P., Kalogerakis, N. (2001). Appled Parameter Estimation for Chemical Engineers. Marcel Dekker, Inc. 4. Ljung, L. (1999). System Identification. Theory for the User. Prentice Hall. 5. Söderström, T., Stoica, P. (1997). Identyfikacja systemów. PWN,					
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example questions/ tasks being completed  dynamic model parameter estimation; process modeling using fuzzy sets; introduction to artificial neural networks.		eResources addresses Adresy na platformie eNauczanie:						
	example questions/	<ul> <li>dynamic model parameter estimation;</li> <li>process modeling using fuzzy sets;</li> </ul>						
Work placement Not applicable	Work placement	Not applicable	Not applicable					

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