GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Uncertainty and sensitivity analysis, PG_00070243
Field of study	Uncertainty and sensitivity analysis

Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Optional subject group
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	assessment

Conducting unit	Department of Statistics and Econometrics -> Faculty of Management and Economics -> Faculties of Gdańsk University of Technology

Name and surname of lecturer (lecturers)	Subject supervisor	dr Samuele Lo Piano
	Teachers	

Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	30.0	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	5.0	25.0	75

Subject objectives	The main objective of the course is to provide students with a comprehensive understanding of the theoretical foundations and practical applications of Uncertainty Analysis and Sensitivity Analysis in the context of quantitative modelling and policy analysis. Students will learn how to systematically identify, quantify, and manage uncertainties in model inputs and how to determine the influence of these inputs on model outputs. The course emphasizes the critical role of UA/SA in enhancing model credibility, transparency, and relevance for decision-making.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U04] is able to prepare and convincingly present the results of specialized analyses, providing in-depth interpretation during debates and meetings with various audiences.	can apply various UA and SA techniques to real-world quantitative models	[SU1] Ocena realizacji zadania [SU4] Ocena umiejętności korzystania z metod i narzędzi
	[K7_W06] knows and understands the principles of evaluating the reliability of utilized data, applying in-depth specialized knowledge in the field of economic analysis.	knows and understands the theoretical foundations of Uncertainty and Sensitivity Analysis.	[SW1] Ocena wiedzy faktograficznej

Subject contents	Course content – lecture
	Introduction to Uncertainty and Sensitivity Analysis: Definitions, motivation, and role in model-based decision-making. Taxonomy of uncertainties (input, parameter, model structure).

Uncertainty Analysis (UA) Methods: Probability distributions, sampling techniques (Monte Carlo, Latin Hypercube Sampling). Visualisation of uncertainty.
Global Sensitivity Analysis (SA) Methods: Variance-based methods (Sobol' indices), regression-based methods, and moment-independent methods (e.g., Delta moment). Interpretation of SA results.
Advanced Topics and Critical Perspectives: Dealing with model structure uncertainty. Introduction to Post-Normal Science and the role of models in high-stakes, high-uncertainty contexts. The final session will focus on Sensitivity Auditing as a critical approach to model evaluation. |
| | Course content – exercises
Introduction to Programming for UA/SA: Setting up the environment (e.g., Python/R libraries). Basic model implementation.

Implementing Uncertainty Analysis: Defining input distributions, performing Monte Carlo and LHS sampling, and analyzing output uncertainty.
Implementing Global Sensitivity Analysis: Calculating and interpreting Sobol' indices and other SA measures. Hands-on application to quantitative models (e.g., in economics, environmental science, or public health).
Case Study and Project Work: Applying UA/SA to a complex case study. Preparation for the final project, which includes a conceptual Sensitivity Auditing component. |

Prerequisites and co-requisites	Basic knowledge of statistics, probability, and mathematical modeling. Familiarity with a programming language (e.g., Python or R) is recommended. Co-requisites: None.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Submission of a report detailing the UA/SA process and a conceptual Sensitivity Auditing of the model.	60.0%	60.0%
Written Exam	60.0%	40.0%

Recommended reading

Basic literature	Saltelli, A., Ratto, M., Andres, T., Campolongo, F., Cariboni, J., Gatelli, D., Saisana, M., & Tarantola, S. (2008). Global Sensitivity Analysis: The Primer. Wiley.
Supplementary literature	Funtowicz, S. O., & Ravetz, J. R. (1993). "Science for the Post-Normal Age." Futures 25(7): 739-755.

Saltelli, A., Funtowicz, S. (2014). "When all models are wrong: more sensitivity auditing is needed." Nature 508: 461-463.
Pielke Jr., R. A. (2007). The Honest Broker: Making Sense of Science in Policy and Politics . Cambridge University Press.
Janssen, P. H. M., Petersen, A. C., & Van der Sluijs, J. P. (2005). "A proposal for a classification of uncertainties for use in environmental assessment." Environmental Science & Policy 8(1): 23-35. |
| eResources addresses | |

| Example issues/ example questions/ tasks being completed | **Example Task:** Perform a Global Sensitivity Analysis on a simple quantitative model (e.g., a growth model, an epidemiological model, or a cost-benefit analysis) to determine which parameters contribute most to the uncertainty in the model's output.

Example Question: Discuss the ethical implications of using a model with high input uncertainty to inform a high-stakes policy decision (e.g., in climate change, public health, or economic forecasting). How does Sensitivity Auditing help in this context?
Example Issue: Analyse a published economic model and perform a conceptual Sensitivity Auditing of its assumptions, boundary conditions, and fitness for the policy question it addresses. |
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| Practical activites within the subject | Not applicable |

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