AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Uncertainty analysis in engineering

Academic year: 2019/2020 Code: ZSDA-3-0083-s ECTS credits: 5

Faculty of: Szkoła Doktorska AGH

Field of study: Szkoła Doktorska AGH Specialty: —

Study level: Third-cycle studies Form and type of study: Full-time studies

Lecture language: English Profile of education: Academic (A) Semester: 0

Course homepage: http://home.agh.edu.pl/~agallina/?UNCERTAINTY_ANALYSIS_IN_ENGINEERING_%28UA%29

Responsible teacher: dr hab. inż. Gallina Alberto (agallina@agh.edu.pl)

Module summary

The course gives students insight into the problem of uncertainty explaining what tools can be adopted to work in a condition of limited knowledge by theoretical and practical work.

Description of learning outcomes for module

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Connections with FLO	Method of learning outcomes verification (form of completion)
Social competence: is able to			
M_K001	Awareness of the responsibility for own work and readiness to comply with the rules of team work and accepting responsibility for tasks performed collectively	SDA3A_K01	Execution of laboratory classes
Skills: he can			
M_U001	Improving software programming skills and ability to integrate different simulation environments	SDA3A_U06, SDA3A_U02	Execution of laboratory classes, Execution of exercises, Execution of a project
M_U002	Student is able to present his own work and justify his/her choices made in the execution of the work.	SDA3A_U02	Presentation
Knowledge: he knows and understands			

M_W001	Awareness of the importance of uncertainty analysis in engineering problems. Understanding of the most common non-deterministic methods and optimization methods used in engineering.	SDA3A_W03, SDA3A_W02	Test, Project, Presentation, Execution of laboratory classes, Execution of a project, Completion of laboratory classes

Number of hours for each form of classes

	Form of classes										
Suma	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
45	15	0	15	15	0	0	0	0	0	0	0

FLO matrix in relation to forms of classes

MLO code	Student after module completion has the knowledge/ knows how to/is able to	Form of classes										
		Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
Social competence: is able to												
M_K001	Awareness of the responsibility for own work and readiness to comply with the rules of team work and accepting responsibility for tasks performed collectively	-	-	+	+	-	-	-	-	-	-	-
Skills: he can												
M_U001	Improving software programming skills and ability to integrate different simulation environments	-	-	+	-	-	-	-	-	-	-	-
M_U002	Student is able to present his own work and justify his/her choices made in the execution of the work.	-	-	-	+	-	-	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	Awareness of the importance of uncertainty analysis in engineering problems. Understanding of the most common non-deterministic methods and optimization methods used in engineering.	+	-	-	-	-	-	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	45 h
Preparation for classes	30 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	40 h
Realization of independently performed tasks	15 h
Examination or Final test	1 h
Contact hours	5 h
Summary student workload	136 h
Module ECTS credits	5 ECTS

Additional information

Module content

Lectures

Introduction
- General concepts/definitions
- Design and Modelling process
- Uncertainty classification
- Uncertainty descriptors
- Uncertainty analyses

Optimization
- Local methods (Newton / Quasi Newton / Newton-Gauss / Neadler Mead / Pattern search)
- Global methods (Simulating Annealing / Genetic Algorithm / Differential Evolution)

Regression models
- Linear regression
- Bayesian linear regression
- Gaussian process linear regression
- Neural Networks

Sensitivity analysis
- Regression analysis
- Morris method
- Sobol method
- Variance based methods
- Other methods

Reliability analysis
- First order reliability method
- Important sampling
- Monte Carlo method

Propagation of uncertainty
- Analytic method

- First Order Second Moment
- Monte Carlo method
- Sampling strategies

Laboratory classes

Fundamentals of calculus of probability
- Basic concepts
- Discrete and continuous random variables
- Fundamental properties
- Conditional properties
- Important distributions
- Maximum likelihood estimator
- Law of large numbers
- Central limit theorem

- Creation of MATALB scripts for testing properties of random theory
- Creation of MATLAB scripts implementing learned methods

Project classes

Development of the project
- Selection of the model and analysis
- Implementation in DAKOTA or MATLAB
- Presentation of results

Introduction to Dakota software
- Fundamentals of Dakota
- Getting started
- Interfacing with external software

Teaching methods and techniques:

Lectures: Nie określono
Laboratory classes: Nie określono
Project classes: Nie określono

Warunki i sposób zaliczenia poszczególnych form zajęć, w tym zasady zaliczeń poprawkowych, a także warunki dopuszczenia do egzaminu:

At the mid of the course a short test on “Calculus of Probability” will be held.
This gives 30% of the final grade.

The 60% of the final grade is given by the group’s project. In the assessment of the project the following aspects will be considered:
- Participation to the project
- Presentation of the project
- Additional questions given at the project’s presentation

The remaining 10% of the final grade is provided by the student’s attendance

Zasady udziału w poszczególnych zajęciach, ze wskazaniem, czy obecność studenta na zajęciach jest obowiązkowa:

Lectures:
– Attendance is mandatory: No
– Participation rules in classes: Nie określono

Laboratory classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Nie określono
Project classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Nie określono

Method of calculating the final grade

At the mid of the course a short test on “Calculus of Probability” will be held.
This gives 30% of the final grade.

The 60% of the final grade is given by the group’s project. In the assessment of the project the following aspects will be considered:
- Participation to the project
- Presentation of the project
- Additional questions given at the project’s presentation

The remaining 10% of the final grade is provided by the student’s attendance

Sposób i tryb wyrównywania zaległości powstałych wskutek nieobecności studenta na zajęciach:

Notes and presentations of the material presented in the lesson will be provided

Prerequisites and additional requirements

- Fundamentals of MATLAB

Recommended literature and teaching resources

Basic:
- Notes provided by the lecturer:

Additional:
- Grinstead, Introduction to probability
- Meyers and Montgomery, Applied statistics and probability for engineers
- Bishop, Pattern recognition and machine learning.

Scientific publications of module course instructors related to the topic of the module

Additional scientific publications not specified

Additional information

None