

**AGH**AGH UNIVERSITY OF SCIENCE  
AND TECHNOLOGY

Module name: Measurement and monitoring in construction and geotechnics

Academic year: 2019/2020 Code: GBUD-2-111-GE-s ECTS credits: 2

Faculty of: Mining and Geoengineering

Field of study: Civil Engineering Specialty: Geotechnical Engineering and Underground Construction

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

Lecture language: English Profile of education: Academic (A) Semester: 1

Course homepage: —

Responsible teacher: dr inż. Szumiński Andrzej (szumi@agh.edu.pl)

### Module summary

Metrology, measuring instruments and measurement techniques used in construction and geotechnics.

### 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	The student is aware of the responsibility for the technical and social consequences of the actions and decisions taken within the scope of their engineering tasks.	BUD2A_K01	Completion of laboratory classes, Execution of laboratory classes, Participation in a discussion, Activity during classes
M_K002	The student understands the need for further study and improves their knowledge and professional qualifications.	BUD2A_K01	Completion of laboratory classes, Execution of laboratory classes, Participation in a discussion, Activity during classes
Skills: he can			
M_U001	The student is able to perform measurements and archive, process, present and interpret the results, taking into account the measurement errors and their sources.	BUD2A_U02, BUD2A_U03, BUD2A_U01	Completion of laboratory classes, Execution of exercises, Activity during classes

M_U002	The student is aware that the results are partial information and, if possible, they should be supplemented by data from other research methods.	BUD2A_U02, BUD2A_U03, BUD2A_U01	Completion of laboratory classes, Execution of laboratory classes, Activity during classes
M_U003	The student is able to determine the optimum for the object of measurement: measured values, the measurement site, and the tools or measuring instruments.	BUD2A_U02, BUD2A_U03, BUD2A_U01	Completion of laboratory classes, Execution of laboratory classes, Activity during classes
M_U004	The student is able to make a critical analysis of the measurement results, based on the type and design of the measuring instrument, the impact of external factors on the result, etc.	BUD2A_U02, BUD2A_U03, BUD2A_U01	Completion of laboratory classes, Execution of exercises, Activity during classes
M_U005	The student is able to use the tools and measuring instruments most common in engineering practice.	BUD2A_U02, BUD2A_U03, BUD2A_U01	Completion of laboratory classes, Execution of laboratory classes, Activity during classes
Knowledge: he knows and understands			
M_W001	The student has knowledge of the basics of metrology, measuring instruments and measurement techniques used in construction and geotechnics.	BUD2A_W03, BUD2A_W06	Completion of laboratory classes, Execution of exercises, Activity during classes
M_W002	The student has knowledge of the use of computers and modern methods of data transfer in measurement and monitoring.	BUD2A_W01, BUD2A_W04, BUD2A_W06	Completion of laboratory classes, Execution of exercises, Activity during classes
M_W003	The student knows and appreciates the role of measurements as a means of supplementing or verifying data obtained by other research and computational methods.	BUD2A_W01, BUD2A_W03, BUD2A_W06	Completion of laboratory classes, Execution of laboratory classes, Participation in a discussion, Activity during classes

## Number of hours for each form of classes

Suma	Form of classes										
	Lectures	Auditorium classes	Laboratory classes	Project classes	Conversation seminar	Seminar classes	Practical classes	Fieldwork classes	Workshops	Prace kontrolne i przejściowe	Lektorat
30	15	0	15	0	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	The student is aware of the responsibility for the technical and social consequences of the actions and decisions taken within the scope of their engineering tasks.	+	-	+	-	-	-	-	-	-	-	-
M_K002	The student understands the need for further study and improves their knowledge and professional qualifications.	+	-	+	-	-	-	-	-	-	-	-
Skills: he can												
M_U001	The student is able to perform measurements and archive, process, present and interpret the results, taking into account the measurement errors and their sources.	+	-	+	-	-	-	-	-	-	-	-
M_U002	The student is aware that the results are partial information and, if possible, they should be supplemented by data from other research methods.	+	-	+	-	-	-	-	-	-	-	-
M_U003	The student is able to determine the optimum for the object of measurement: measured values, the measurement site, and the tools or measuring instruments.	+	-	+	-	-	-	-	-	-	-	-
M_U004	The student is able to make a critical analysis of the measurement results, based on the type and design of the measuring instrument, the impact of external factors on the result, etc.	+	-	+	-	-	-	-	-	-	-	-
M_U005	The student is able to use the tools and measuring instruments most common in engineering practice.	+	-	+	-	-	-	-	-	-	-	-
Knowledge: he knows and understands												
M_W001	The student has knowledge of the basics of metrology, measuring instruments and measurement techniques used in construction and geotechnics.	+	-	+	-	-	-	-	-	-	-	-
M_W002	The student has knowledge of the use of computers and modern methods of data transfer in measurement and monitoring.	+	-	+	-	-	-	-	-	-	-	-

M_W003	The student knows and appreciates the role of measurements as a means of supplementing or verifying data obtained by other research and computational methods.	+	-	+	-	-	-	-	-	-	-	-
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## Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	30 h
Preparation for classes	10 h
przygotowanie projektu, prezentacji, pracy pisemnej, sprawozdania	5 h
Realization of independently performed tasks	7 h
Summary student workload	52 h
Module ECTS credits	2 ECTS

## Additional information

### Module content

#### Lectures

1. Measurements as a basis for inspections and expertise on the behavior of engineering structures.
2. Basic metrology, measurement, measurement instrumentation and systems, principles of measurement of physical quantities.
3. Basics of statistical evaluation of measurement results, sources and types of measurement errors.
4. Methods of presentation and interpretation of measurement results.
5. Types of measurements in construction and geotechnical engineering, measured values and measuring apparatus.
6. Monitoring, monitoring systems and the type of information collected; determination, detection and warning of threats.
7. Systems and programs to manage and control measurements and monitoring.

#### Laboratory classes

1. Measurements of stress and strain in structural elements, using the resistance tensometry method.
2. Measurements of stress and strain by optical methods: photo-elasticity and interferometry.
3. The study of the mechanical properties of rock samples in a servo-controlled testing machine.
4. GPS displacement monitoring, using RTK measurement technique.
5. Presentation of the selected system for monitoring the technical condition of the building object.

### **Teaching methods and techniques:**

Lectures: Treści prezentowane na wykładzie są przekazywane w formie prezentacji multimedialnej w połączeniu z klasycznym wykładem tablicowym wzbogaconymi o pokazy odnoszące się do prezentowanych zagadnień.

Laboratory classes: W trakcie zajęć laboratoryjnych studenci samodzielnie rozwiązują zadany problem praktyczny, dobierając odpowiednie narzędzia. Prowadzący stymuluje grupę do refleksji nad problemem, tak by otrzymane wyniki miały wysoką wartość merytoryczną.

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

Passing tutorials can be done within one primary deadline or one retake.

Detailed assessment for classes is agreed by the lecturers and communicated to students at the beginning of the semester.

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

Lectures:

- Attendance is mandatory: No

- Participation rules in classes: Studenci uczestniczą w zajęciach poznając kolejne treści nauczania zgodnie z sylabusem przedmiotu. Studenci winni na bieżąco zadawać pytania i wyjaśniać wątpliwości. Rejestracja audiowizualna wykładu wymaga zgody prowadzącego.

Laboratory classes:

- Attendance is mandatory: Yes

- Participation rules in classes: Studenci wykonują ćwiczenia laboratoryjne zgodnie z materiałami udostępnionymi przez prowadzącego. Student jest zobowiązany do przygotowania się w przedmiocie wykonywanego ćwiczenia, co może zostać zweryfikowane kolokwium w formie ustnej lub pisemnej. Zaliczenie zajęć odbywa się na podstawie zaprezentowania rozwiązania postawionego problemu. Zaliczenie modułu jest możliwe po zaliczeniu wszystkich zajęć laboratoryjnych.

### **Method of calculating the final grade**

The final grade is the average credit from classes and lectures.

Credit for lectures: attendance at all lectures - 5.0; each absence lowers the grade by half a point.

Credit for classes is the average of all experiments performed.

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

Excused absences from classes may be made up for with another group, with the consent of both lecturers and provided that the classes cover the same topic and that there are seats available.

### **Prerequisites and additional requirements**

Admission and passing the course requires prior passing the courses: Theoretical Mechanics and Strength of Materials.

### **Recommended literature and teaching resources**

1. Alan S. Morris, Reza Langari, Measurement and Instrumentation, Theory and Application. Elsevier Science 2011.

2. John T. Germaine, Amy V. Germaine; Geotechnical Laboratory Measurements for Engineers. Wiley, June 2009.

3. Robert B. Northrop, Introduction to Instrumentation and Measurements. Taylor&Francis Group 2005.

4. Metrology - in short, 3rd edition, EURAMET 2008, 84 p. ([www.euramet.org](http://www.euramet.org)).

5. S. A. Bell, A beginner's guide to uncertainty in measurement, Measurement Good Practice Guide No. 11, National Physical Laboratory 2001, 41 p. ([www.npl.co.uk](http://www.npl.co.uk)).

6. Wikipedia (Metrology): <https://en.wikipedia.org/wiki/Metrology>

7. Wikipedia (Instrumentation): <https://en.wikipedia.org/wiki/Instrumentation>.

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

1. Szumiński A., Klisowski R.: The influence of material age on the post-failure characteristics of cement mortar specimens. *Budownictwo Górnicze i Tunelowe*, no 3/2010.
2. Flisiak D., Klisowski R., Szumiński A.: *Metodyka badań a uzyskiwane charakterystyki pozniszczeniowe - uwagi o potrzebie standaryzacji*, XXV Zimowa Szkoła Mechaniki Górniczej, Kraków 2002.
3. Flisiak D., Klisowski R., Szumiński A.: *Uwagi na temat sposobu prowadzenia testu jednoosiowego ściskania w serwosterowalnej maszynie wytrzymałościowej*, XXV Zimowa Szkoła Mechaniki Górniczej, Kraków 2002.

### **Additional information**

Passing tutorials can be done within one primary deadline or one retake. Attendance at lectures and classes is mandatory. Excused absences from classes may be made up for with another group, with the consent of both lecturers and provided that the classes cover the same topic and that there are seats available. A student who skipped more than 20% of the classes cannot get credit and shall not be allowed to pass the retake.

Detailed assessment for classes is agreed by the lecturers and communicated to students at the beginning of the semester.