AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Module name: Rock mechanics

Academic year: 2019/2020 Code: ZSDA-3-0199-s ECTS credits: 4

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: Polski i Angielski Profile of education: Academic (A) Semester: 0

Course homepage: —

Responsible teacher: dr hab. inż. Jakubowski Jacek (Jacek.Jakubowski@agh.edu.pl)

Module summary

Key concepts and methods of rock mechanics, advanced approaches to jointed rock mass mechanics. Lab tests, rock mass quality, joint network description, jointed rock mass models, the block theory, numerical simulations. The course will be offered from autumn 2020, in Polish or English.

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	Is aware of his/her competencies in the area of rock mechanics and paths of their further development.	SDA3A_K01	Execution of laboratory classes, Test results, Participation in a discussion, Activity during classes
Skills: he can			
M_U001	Student understands the difference between the mechanical properties of rock material and rock mass. Can use index properties to perform classification of rock mass and assess its strength and deformability.	SDA3A_U02, SDA3A_U01	Test results, Execution of laboratory classes, Participation in a discussion, Activity during classes
M_U002	Student knows joint and joint network attributes, is able to select methods for their description and site investigation.	SDA3A_U02, SDA3A_U01	Test results, Execution of laboratory classes, Participation in a discussion, Activity during classes
Knowledge: he knows and understands			

M_W001	Student can apply the elasticity theory for rock mechanics and understands the assumptions and deficiencies of this approach.	SDA3A_W02, SDA3A_W01	Test results, Execution of laboratory classes, Participation in a discussion, Activity during classes
M_W002	Student knows concepts and methods of rock mechanics, specifically the jointed rock mass approaches	SDA3A_W02, SDA3A_W01	Test results, Execution of laboratory classes, Participation in a discussion, Activity during 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	30	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	Is aware of his/her competencies in the area of rock mechanics and paths of their further development.	+	-	+	-	-	-	-	-	-	-	-
Skills: he can												
M_U001	Student understands the difference between the mechanical properties of rock material and rock mass. Can use index properties to perform classification of rock mass and assess its strength and deformability.	+	-	+	-	-	-	-	-	-	-	-
M_U002	Student knows joint and joint network attributes, is able to select methods for their description and site investigation.	+	-	+	-	-	-	-	-	-	-	-
Knowledge: he knows and understands												

M_W001	Student can apply the elasticity theory for rock mechanics and understands the assumptions and deficiencies of this approach.	+	-	+	-	-	-	-	-	-	-	-
M_W002	Student knows concepts and methods of rock mechanics, specifically the jointed rock mass approaches	+	-	+	-	-	-	-	-	-	-	-

Student workload (ECTS credits balance)

Student activity form	Student workload
Udział w zajęciach dydaktycznych/praktyka	45 h
Preparation for classes	25 h
Realization of independently performed tasks	25 h
Summary student workload	95 h
Module ECTS credits	4 ECTS

Additional information

Module content

Lectures

Rock Mechanics problems, key concepts and approaches, fields of application. An overview of Rock Mechanics methods (laboratory tests, in-situ measurements and site investigations, theoretical, empirical, physical and numerical models). Stress tensor and elements of the linear elasticity theory. Failure criteria. Initial stresses in rock mass: theory, measurements and implications. Stress around underground openings. Joint and joint network attributes. Site investigation, data collection and visualization. Mechanical models of joints. Mechanical models of jointed rock mass. Engineering rock mass classifications. Strength and deformability of rock mass. Basic concepts of the block theory for rock slopes and underground openings.

Laboratory classes

Laboratory classes are performed, in the form of, alternatively: (a) testing mechanical properties of rock mass and rock material (eg. Lang’s experiment, uniaxial compression test, splitting tensile test, conventional triaxial compression test, full stress-strain characteristics), or (b) computer workshops with numerical simulations of rock mass behaviour (stress, strain and energy calculus with Matlab, defining and solving problems of rock engineering with selected software tools: FEM, DEM or wedge stability analysis).

Teaching methods and techniques:

Lectures: The content presented at the lectures is provided in the form of a presentation in combination with a classic lecture panel enriched with demonstrations and forms of active participation of students. Laboratory classes: Students perform experiments or solve practical problems independently under

limited supervision of a tutor. Students learn the experimental methods or acquire other practical skills

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

The final test includes the range of material from the lectures and classes. A pass may be obtained at the primary date or at one resit date.

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

Lectures:
– Attendance is mandatory: Yes
– Participation rules in classes: Students participate in classes learning further content of teaching according to the syllabus of the subject. Students are encouraged and expected to ask questions. Audiovisual recording of the lectures requires the teacher’s written consent.
Laboratory classes:
– Attendance is mandatory: Yes
– Participation rules in classes: Students joining the classes should be prepared in the scope indicated by
the teacher (eg in the form of task sets). Student’s work assessment can be based on oral or written statements

Method of calculating the final grade

assignments (50%), final test (50%)

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

Justified absences at classes may be made up with a different group providing the material implemented at the classes is the same.

Prerequisites and additional requirements

Courses in basic geology or strength of materials or equivalent introduction to elasticity or introductory course in geomechanics at any earlier stage of studies would be an advantage.

Recommended literature and teaching resources

Brady B., Brown E. Rock mechanics for underground mining;
Goodman R.E. Introduction to Rock Mechanics;
Mogi K. Experimental Rock Mechanics;
Goodman R, Shi G-H. The Block Theory and its Application to Rock Engineering;
Bieniawski Z. Engineering rock mass classifications;
Hoek E. Practical Rock Engineering;
Hoek E., Bray J. Rock Slope Engineering;
Thiel K. Rock mechanics in hydroengineering;
Eberhardt E. Rock Engineering, Practice and Design;

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

1. Rock ledge support design : a deterministic and stochastic approach / J. JAKUBOWSKI, J. B. Stypulkowski // W: Eurock 2013: rock mechanics for resources, energy and environment: London : CRC Press, Taylor &
Francis Group, 2013.
2. Top of rock investigations for secant piles at the Bronx shaft / J. JAKUBOWSKI, J. B. Stypułkowski // W: Underground infrastructure of Urban Areas 2 / Boca Raton [etc.] : CRC Press/ Balkema, cop. 2012
3. Statistical simulation of 3D blocky structure – a guide for tunnel design in jointed rock / J.JAKUBOWSKI // W: Rock mechanics : a challenge for society : proceedings of the ISRM regional symposium : EUROCK 2001 : Espoo Finland 2001 / A. A. Balkema, 2001. — S. 351–355. — Bibliogr. s. 355.

Additional information

Temporary policy and exceptions will be presented at the first lecture. Special circumstances of obtaining a pass will be presented by the tutors at the beginning of term. The course will be offered from autumn 2020, in Polish or English.