# Grading criteria for AF2602 Rock Mechanics

## Intended learning outcomes

The objective of this course is to give the students basic knowledge of rock engineering design, including the determination of (1) intact rock and rock mass mechanical properties, (2) rock mass strength, (3) stresses and deformations around excavations, and (4) different types of failure mechanisms. After the course, the students shall be able to:

1. Account for the fundamental differences between the rock mass and other types of man-made construction materials.

2. Describe ground behavior for different geological conditions and identify common geological uncertainties.

3. Use different rock mass classifications systems such as the Q-system, the Rock Mass Rating (RMR) and the Geological Strength Index (GSI).

4. Determine the mechanical properties of intact rock, joints and rock masses to be used as input to the rock mechanical calculations.

5. Calculate radial and tangential stresses and deformations around underground openings.

6. Analyze the interaction between the rock mass and the installed support in tunnels with the ground reaction curve concept.

7. Analyze typical stability problems in rock engineering such as block stability, arching stability and slope stability.

These seven *intended learning outcomes* (ILOs) are currently examined through three separate modules: ÖVN1 (Assignment 1, 3, 4, an the field trip), LAB1 (Assignment 2), and TEN1 (written final exam). This document clarifies in which module each course objective is examined and what level of understanding that the student needs to be able to show to be awarded a certain grade (A-E, and Fx).

## Examination of intended learning outcomes

The seven ILOs are examined in the three examination modules in accordance with Table 1.

## Criterion-referenced grading criteria for the examination

From 2018, we apply criterion-referenced grading criteria in this course. This implies an increased transparency regarding the required level of knowledge to be awarded a certain grade. Table 2 shows the highest grade that can be awarded for each of the seven ILOs. Table 3 describes the level of understanding that the student must show for each grade.

Table 1. Examination modules and corresponding course assignments (AS) versus intended learning outcomes.

| **Intended learning outcomes** | **ÖVN1 (AS1)** | **ÖVN1 (AS3)** | **ÖVN1 (AS4)** | **ÖVN1 (AS5)** | **LAB1 (AS2)** | **TEN1** |
|---|---|---|---|---|---|---|
| 1. Account for the fundamental differences between the rock mass and other types of man-made construction materials. | X | | | | | X |
| 2. Describe ground behavior for different geological conditions and identify common geological uncertainties. | X | | | | | X |
| 3. Use different rock mass classifications systems such as the Q-system, the Rock Mass Rating (RMR) and the Geological Strength Index (GSI). | | | | | X | X |
| 4. Determine the mechanical properties of intact rock, joints and rock masses to be used as input to the rock mechanical calculations. | | X | | | X | X |
| 5. Calculate radial and tangential stresses and deformations around underground openings. | | X | X | | | X |
| 6. Analyze the interaction between the rock mass and the installed support in tunnels with the ground reaction curve concept. | | | X | | | X |
| 7. Analyze typical stability problems in rock engineering such as block stability, arching stability and slope stability. | | | | X | | X |

Table 2. Highest grades that can be awarded for each intended learning outcome.

| **Intended learning outcomes** | **E** | **D** | **C** | **B** | **A** |
|---|---|---|---|---|---|
| 1. Account for the fundamental differences between the rock mass and other types of man-made construction materials. | → | → | X | | |
| 2. Describe ground behavior for different geological conditions and identify common geological uncertainties. | → | → | → | → | X |
| 3. Use different rock mass classifications systems such as the Q-system, the Rock Mass Rating (RMR) and the Geological Strength Index (GSI). | → | → | X | | |
| 4. Determine the mechanical properties of intact rock, joints and rock masses to be used as input to the rock mechanical calculations. | → | → | X | | |
| 5. Calculate radial and tangential stresses and deformations around underground openings. | → | → | X | | |
| 6. Analyze the interaction between the rock mass and the installed support in tunnels with the ground reaction curve concept. | → | → | → | → | X |
| 7. Analyze typical stability problems in rock engineering such as block stability, arching stability and slope stability. | → | → | → | → | X |

Table 3. Criterion-referenced grading criteria for which level of understanding that the student needs to be able to show for each grade and intended learning outcome. Important differences between grades are highlighted in italics.

| **Intended learning outcomes** | **E** | **D** | **C** | **B** | **A** |
|---|---|---|---|---|---|
| 1. Account for the fundamental differences between the rock mass and other types of man-made construction materials. | Account for the fundamental differences *in a general sense* between the rock mass and other types of man-made construction materials. | (Partly satisfying criterion for C) | Account for the fundamental differences *in detail* between the rock mass and other types of man-made construction materials. | - | - |
| 2. Describe ground behavior for different geological conditions and identify common geological uncertainties. | *Provide examples* of ground behaviour and how they can relate to different geological conditions and be managed differently depending on the level of uncertainty. | (Partly satisfying criterion for C) | *Exhaustively describe* ground behaviour types and how they relate to geological conditions and can be managed differently depending on the level of uncertainty. | (Partly satisfying criterion for A) | *Suggest suitable methodologies* to manage various ground behaviour types with respect to the current level of uncertainty. |
| 3. Use different rock mass classifications systems such as the Q-system, the Rock Mass Rating (RMR) and the Geological Strength Index (GSI). | *Account for the general principles* in characterising and classifying rock masses with different classification systems. | (Partly satisfying criterion for C) | Characterise and classify rock masses and *present the result clearly with respect to relevant context*. | - | - |
| 4. Determine the mechanical properties of intact rock, joints and rock masses to be used as input to the rock mechanical calculations. | Determine mechanical properties based on established geological conditions. | (Partly satisfying criterion for C) | Determine *and present clearly* mechanical properties based on established geological conditions. | - | - |
| 5. Calculate radial and tangential stresses and deformations around underground openings. | Calculate stresses and deformations *for typical cases*, based on provided data. | (Partly satisfying criterion for C) | Calculate stresses and deformations *for more advanced cases*, based on provided data. | - | - |
| 6. Analyze the interaction between the rock mass and the installed support in tunnels with the ground reaction curve (GRC) concept. | Calculate tunnel and support deformations with the GRC concept *for basic cases and conditions*. | (Partly satisfying criterion for C) | Analyse the interaction between the rock mass and the installed support, *with respect to some aspects* mentioned in the criterion for grade A. | (Partly satisfying criterion for A) | Analyse the interaction between the rock mass and the installed support, *accounting holistically and exhaustively* for shotcrete curing time, blast length, and tunnel face advance rate, as well as the structural interaction between the structural components. |
| 7. Analyze typical stability problems in rock engineering such as block stability, arching stability and slope stability. | Solve *simplified* rock mechanical problems | (Partly satisfying criterion for C) | Solve *typical* rock mechanical problems | (Partly satisfying criterion for A) | Solve *complex* rock mechanical problems |

## Design of written exam with respect to awarded grades

To give the students the possibility to account for their knowledge and understanding with respect to the grading criteria in Table 3, the written exam is graded based on points awarded on the three levels E, C and A. In the exam, the awarded number of points for each question is shown as (E/C/A), e.g. (2/1/1), which implies that the question gives a maximum of 2 E-points, 1 C-point and 1 A-point.

The student's grade depends on the collective number of points, as described in the following. **The stated percentages are approximate to give the general idea**; i.e., they may be different for each exam opportunity.

| Grade | Requirement |
|---|---|
| Fx | Requirements for E less 1 point. |
| E | 50% of all exam points (disregarding bonus from assignments; see below) |
| D | 55% of all points (incl. bonus), incl. 30% of the total number of C-points and A-points |
| C | 65% of all points (incl. bonus), incl. 50% of the total number of C-points and A-points |
| B | 75% of all points (incl. bonus), incl. 40% of the A-points |
| A | 85% of all points (incl. bonus), incl. 80% of the A-points |

### Bonus points

Up to 8 bonus points can be awarded for excellently presented group assignments and quizzes. Bonus points are categorised as level C points. Note that bonus points cannot be used to attain grade E; however, they are included in the total point requirement for grades D-A. Bonus points are kept with the student for all future exams. Assignments cannot be re-taken for a higher grade once they have been passed.

### Point increase in exams from 2018

From 2018, we will not award 0.5 points for partially solved questions; instead, we will double the number of points on the exam compared to previous exams, so that 2 points in 2018 and future exams equal 1 point in the old system in terms of expected workload.

The March exam of 2017 has been revised in accordance to the new system and is provided on Canvas as an example. (The point increase is however not reflected in the revised example exam on Canvas.) The exams from 2018 follow the new system.

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