Materialvetenskap, KTH

# Mechanical Properties of Materials, MH2032, 6hp

## Course PM for 2020

### *Teachers*


| | | | | |
|---|---|---|---|---|
| Examiner: | Stefan Jonsson | (SJ) | 070-290 84 04 | jonsson@kth.se |
| Administrator: | Anders Eliasson | (AE) | 08-790 72 55 | anderse@kth.se |


### *Schedule* (updated 2020-10-20), Le = Lecture, Ex = Exercise

All activities will by online through ZOOM and will be recorded. There will be a combination of pre-recorded and live activities. The recordings will be found at play.kth.se. The ZOOM meeting IDs are given in the table below. The full invitations are also given in a word document on Canvas.

*Table 1 Activities in chronological order*

| Date | Time | Meeting ID | Activity | Subject |
|---|---|---|---|---|
| Oct 27 | 10-12 | 657 1254 8187 | Le1 | Plastic deformation |
| Oct 29 | 13-15 | 615 8371 1179 | Le2 | Plastic deformation |
| Nov 3 | 10-12 | 690 4418 4474 | Le3 | Dislocation theory |
| Nov 5 | 14-16 | 662 7179 8236 | Le4 | Dislocation theory/Hard mech. |
| Nov 10 | 10-12 | 654 3707 4721 | Le5 | Hardening mechanisms |
| Nov 12 | 13-15 | 636 0746 8752 | Le6 | Hardening mechanisms |
| Nov 18 | 08-10 | Digital | **Quizz** | Quizz |
| Nov 19 | 13-15 | 657 2700 8383 | Ex1 | |
| Nov 24 | 10-12 | 615 5943 5309 | Le7 | Static fracture |
| Nov 25 | 15-17 | 646 2521 4372 | Ex2 | |
| Nov 26 | 13-15 | 667 0554 6778 | Le8 | Fatigue |
| Dec 1 | 10-12 | 686 9557 9993 | Ex3 | |
| Dec 3 | 13-15 | 654 4586 3213 | Le9 | Creep |
| **Dec 3** | **24.00** | | | **Hand in report for SEM1** |
| Dec 8 | 10-12 | 653 7575 8586 | Le10 | Questions from students |
| Dec 10 | 13-16 | 651 7533 4035 | SEM | Seminar |
| Jan 15 | 08-13 | Digital | TENA | Exam |

An updated schedule is found at:
https://www.kth.se/social/course/MH2032/calendar/

## *Syllabus*

The course covers basic concepts of the mechanical properties of *metals*. Plastic deformation, from continuum- and crystal plasticity perspectives, are followed by basic descriptions of dislocation properties, which are used for describing the hardening mechanisms. Then, follows; basic knowledge of static fracture, ductile and brittle fracture which is developed further in a chapter on fatigue. Finally, strain ageing and creep are covered.

## *Course goals*

After the course, the students should be able to:

1. Explain the basic principles of deformation of metals
2. Explain the basic principles of fracture in metals and recognize typical fracture surfaces.
3. Apply basic models for the description of mechanical properties.
4. Evaluate the impact of mechanical properties of metals.

| | |
|---|---|
| Course goal 1 | "deformation", includes plastic deformation, deformation mechanisms, dislocation theory, hardening mechanisms, strain ageing and creep. |
| Course goal 2 | "fracture", includes static fracture and fatigue. |
| Course goal 3 | "modelling", includes modelling of mechanical properties. |
| Course goal 4 | includes the seminar. |

## *Examination (According to LADOK)*

| | | |
|---|---|---|
| • INLA | Voluntary hand-in problems, 0hp | Grades: E, FX, F |
| • KON1 | Voluntary quiz, 0hp | Grades: A, B, C, D, E, FX, F |
| • SEM1 | Seminar, 2.0 hp | Grades: P,F |
| • TENA | Exam, 4.0 hp | Grades: A, B, C, D, E, FX, F |

**INLA** examines the basic level for modelling and is voluntary. If you have passed INLA you have grade E on modelling.

**KON1** examines deformation, except strain ageing and creep, and is voluntary. The grade received at KON1 is transferred to the exam. See further below.

**SEM1** is examined at a seminar when a chosen task is presented. The presentation should include relevant information and be correct. A written report should be handed in 1 week before the presentation showing what is going to be presented. Normally, this includes a few pages of text and some figures. *In order to pass*, it is necessary that the student (or group of students) understands the task, is prepared and presents the issue clearly. Relevant figures should be included in the presentation and written report. The assignment requires that necessary sources of information are searched and studied. The most relevant information about the subject should be presented to the class. It is very nice if you could put the context of your subject into a relevant example, or show examples of observations or plausible effects of the studied phenomenon.

**TENA** consists of two parts, written after each other. Part 1, 2h, is without aids and examines deformation and fracture. Part 2, 3h, includes aids and examines modelling. The approved aids of part 2 include material that is generally available for an engineer, i.e. calculator, books (including the course compendium), formula handbooks (including the course's collection of

formulae). However, it is *not allowed* to bring solutions to exercises, old exams, hand-in problems and so on, or private notes.

**Digital examination** in Canvas will be used for KON1 and TENA. It will then be possible to use programs like Excel and Matlab to construct diagrams and make calculations. It will also be possible to solve the problems and to make sketches on a piece of paper. Then the papers are to be photographed by a mobile phone and uploaded.

**The course grade** is given when all course goals (1-4) are passed and is based on the number of points received from course goals 1-3. The situation is explained from the table below. There are 9 questions, Q1-Q9 divided on the different course goals.

KON1 and TENA(1) (closed part of exam) have Q1-Q3 and the best result is counted. Hence, a good result of KON1 makes it unnecessary to answer Q1-Q3 in the exam. However, Q4 must be answered. The sum, S1, of Q1-Q4 is tested against the requirements of FX and E. It should be emphasized that Q1-Q3 will all be about deformation but that different subthemes are likely to appear in KON1 and TENA(1).

Q5 and Q6 are only tested in TENA(1) and their sum, S2, is tested against the requirements of FX and E.

CG3 can be passed (E) in two ways: 1) by handing in solutions to five problems (5x5=25p) or 2) by getting the sum, S3≥ 25, of Q7-Q9 in the closed part of the exam, TENA(2), where aids are allowed.

CG4 is passed when an appropriate report has been handed in and the selected subject has been presented during a seminar.

When course goals 1-4 are passed, the course is passed with grade E.

When the grades on the advanced level, A-D, are considered, half of the points from KON1 will be given as a bonus. The maximum grand total of points will then be 108. The grades will be given as a percentage of this number, as indicated in the bottom row of the table. It should be emphasized that slight adjustments may be needed, for instance when a question is misleading or in error, or if the questions appear to have been a bit too difficult.

*Table 2 Examination overview showing the maximum points*

| | CG1, deformation | | | | CG2, fracture | | GC3, modelling | | | CG4 |
|---|---|---|---|---|---|---|---|---|---|---|
| Questions | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | |
| KON1 | 8 | 8 | 8 | | | | | | | |
| INLA | | | | | | | 5x5=25 | | | |
| SEM | | | | | | | | | | P |
| TENA(1) | 8 | 8 | 8 | 8 | 8 | 8 | | | | |
| TENA(2) | | | | | | | 16 | 16 | 16 | |
| | Best of KON1 and TENA | | | | | | | | | |
| Sums | S1 | | | | S2 | | S3 | | | |
| S≥FX/E | FX14 E16 | | | | FX7 E8 | | FX22 E25 | | | |
| | | | | | | | | | | |
| | Fulfilling all above CGs gives grade E | | | | | | | | | |
| Bonus | ½ of KON1 | | | | | | | | | |
| Max | $4 \cdot 8 + 0.5 \cdot 3 \cdot 8 = 44$ | | | | 16 | | 48 | | | |
| Grand tot | $44 + 16 + 48 = 108$ | | | | | | | | | |
| Grade | A 90%, B 80%, C 70%, D 60 % (A97, B86, C75, D65) | | | | | | | | | |

The points will not be reported, but rather used for creating a grade. They will be communicated to the course participants.

## Complimentary work

It is possible to hand in hand-written (scanned and Emailed is OK) solutions to the exam problems where FX was given. If F is received on SEM1, you have to hand in a new report and make an agreement with the examiner for a new presentation.

## Seminar

Each student, or pair of students, choses a subject from the list available on Canvas. A written report should be handed in by Email to jonsson@kth.se. Note the dead line for handing in the report, listed in the schedule, above. Naturally, the expectations of the report and presentation are bigger for a group of students, than for a single student. As we have 3h for the seminar, a one-person presentation must be limited to about 6min.

## Course material

| | |
|---|---|
| Compendia<br>Paper copies available on request | Mechanical Properties of Metals and Dislocation Theory from an Engineer's Perspective, S. Jonsson. |
| Canvas | Compendia and all other materials |

## Any other business

Suggestions for improving the course are most welcome. Please tell me about errors or ambiguities that you find in the course material by sending an email to Stefan Jonsson, jonsson@kth.se.

With reservations for typing errors. Please, tell me about any ambiguities in the text.

2020-10-26, Stefan Jonsson