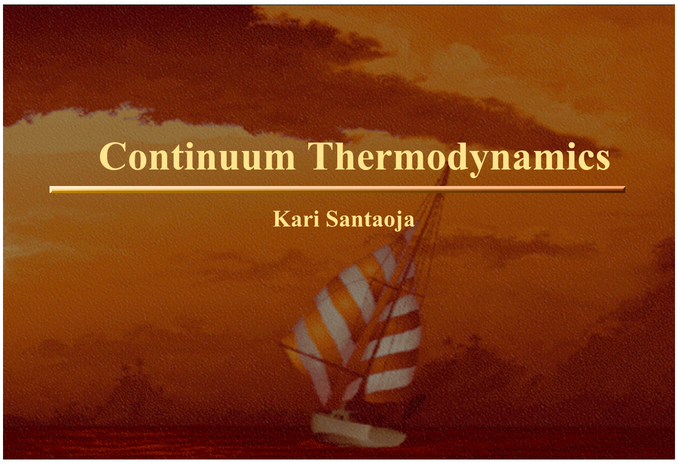
MEC-E8002 Continuum mechanics and material modelling (5,0 cr) 2019

January 27, 2019

What to read for examination

This document gives some hints and instructions concerning what to read for the examination on the present course.



The problems in the examination have the same style as the homework and what was presented during the lectures. The following list gives more detailed instructions what to read in individual chapters and sections of the *Lecture notes on continuum thermodynamics*. At the end of the list the important parts of the lecture notes on the *Extended Levenberg-Marquardt method for Determination of Values for Material Parameters* are highlighted.

Chapter 1; Have a brief look. Skip Section 1.2.

Chapter 2; A copy of this chapter is given to students in the examination. Be sure that you understand the content of Chapter 2 and that you do not have time to study Chapter 2 during the examination. Read carefully pages 31-39.

Chapter 3; The end of Section 3.2 starting from above Equation (3.45) is very important. Skip Section 3.3. Have a brief look at Section 3.4. Section 3.5 is very important. Be sure that you can derive results (3.81) and (3.82). Skip Sections 3.6, 3.7 and 3.8, but Result (3.108) is important to know.

Chapter 4; The idea of Section 4.1 is important but skip the detailed derivation. The same holds for Section 4.2. The concepts of Sections 4.1 and 4.2 might be asked in the examination, but not the detailed mathematical derivation. Thus, study the idea that from local Equilibrium Eqs (1) one can get Eqs (4.13), $(4.23)_2$ and $(4.40)_2$ which form the foundation for derivation of the differential equation for beam bending. You have to know that using Eq. (4.41) and Fig. 2 one can derive Definition (4.53). Skip Section 4.3.

Chapter 5; Have a brief look.

Chapter 6; Have a brief look at Section 6.1. Section 6.2 is important. Study to derive State Equations (6.9). Skip the contents of pages 106-107, but study the gas inside the cylinder and the bar in the tension examples on pages 108-109.

Chapter 7; Read.

Chapter 8; Study the beginning of Chapter 8 and in Section 8.1 have a brief look of from beginning to Equation (12). Study to understand the terms of Energy Equation (8.27). Read the rest of the Section 8.1 starting from Expression (8.27). Skip Section 8.2.

Chapter 9; Equation (9.1) and the end Section 9.1 starting from above Equation (9.9). Study to understand the terms of the local form of the second law of thermodynamics, i.e. Expression (9.9). Skip Section 9.2.

Chapter 10; Look at pages 129-133 briefly. The italicised text at the bottom of page 129, Expression (10.4) and Figure 2 on page 133 are important. Skip the other material of this section starting from the top of page 132.

Chapter 11; You must be able to explain the reason for the existence of the difference $\boldsymbol{\varepsilon} - \boldsymbol{\varepsilon}^{\mathrm{i}}$ in Equation (11.8) and for the reason material models are written in terms of the specific Helmholtz free energy ψ instead of the specific internal energy u. You have to remember State Equations (11.11), (11.12), (11.14), (11.18), (11.20), (11.23) and (11.24) and you must be capable of extending these state equation for a new set of state variables, as is done in Homework 5. The method for replacing the specific internal energy u by the specific Helmholtz free energy ψ belongs here. The same holds for the relation between the specific Helmholtz free energy ψ and the specific Gibbs free energy g. A verbal explanation is enough and you need not be able to give a detailed derivation. Skip Section 11.2.

Chapter 12; Only the idea expressed before Section 12.1. You must know how to apply Equation (12.10).

Chapter 13; You need to be able to derive Expression (13.11) and Clausius-Duhem Inequality (13.12) from the given local form of the first law of thermodynamics, Expression (13.1), and of the local form of the second law of thermodynamics, Expression (13.2). Be sure that you can derive Rate (13.9). You must be able to write Separations (13.13) and (13.14). You need to know how to extend these equations for a new set of variables [cf. Homework 5].

Chapter 14; Study the following topics: Read the beginning of the chapter up to Equation (14.7) [not included]. You must be able to write Normality Rule (14.20), (14.21), (14.24), (14.25) and (14.27) as well as to extend them for a new material model. The same holds for Conditions (14.22) and (14.28).

Chapter 15; Read up to the middle of page 166, to the paragraph starting “The dissipative part of the material model ...”. Study to derive Result (15.7). You have to remember that the result of Chapter 15 given in the title of Chapter 15 holds for separated dissipation potentials as well.

Chapter 16; Skip.

Chapter 17; Skip.

Chapter 18; Skip.

Chapter 19; Read carefully. This chapter is important.

Chapter 20; Read.

Chapter 21; Skip Sections 21.2, 21.3 and 21.5.

Chapter 22; Only Section 22.1.4 “Strain property...”.

Chapter 23; Read the whole chapter excluding Sections “23.1 Maxwell fluid” and “23.2 Kelvin-Voigt solid”.

Chapter 24; Read from the beginning of the chapter to Equation (24.9) and then from the beginning of Section 24.2 to Equation (24.33). Read Section 24.3.

Chapter 25; Skip.

Chapter 26; Read. The difference between Figures 2 and 3 is important to recognise. Read carefully Sections 26.4 and 26.5. Skip the end of Section 26.8 starting from Equation (26.96). In Section 26.11 headed “Other types of damage” be ready to explain the micromechanical roles of the components in Expressions (26.136) and to draw a figure like Figure 26.13.

Chapter 27; Read first two pages.

Chapter 28; Skip.

Chapter 29; Skip

Appendices; I have prepared a collection of the main results of the appendices. You can take it with you to the examination. Make sure that you understand the content of this collection.

Extended L-M Method; Chapter 3. Especially the derivation of the Levenberg-Marquardt method starting from Expression (3.8) and continuing to Equation (3.16). The iteration procedure on page 20 is also important.

The material on the implementation of the material model into Abaqus-UMAT.