

RAK.RS.300 Introduction to materials modelling

Autumn 2026

Lectures: Lectures at 14.15-17 on Tuesdays RH215, Reijo Kouhia, office RM216, tel 040-8490561, e-mail: reijo.kouhia@tuni.fi.

Exercises are voluntary. In the exercise hours students solve the problems with the help of assistant. Exercises 3 h/week on Wednesdays 14.15-17 at RI207. Assistant: Sulata Dhakal.

Goal: Basic knowledge of the most common materials models (elastic, elasto-plastic, viscoelastic, viscoplastic, damage). Decomposition of stress and strain, invariants. The symmetry properties are treated using the invariant theory.

Literature: Lecture notes, which can be found from <http://webpages.tuni.fi/rakmek/?id=6> and in Moodle. Highly recommendable books are N.S. Ottosen, M. Ristinmaa, Mechanics of Constitutive Modelling and J. Lemaitre, J.-L. Chaboche, *Mechanics of Solid Materials*.

Grading: Exam. Weekly exercise exams can result in increase of exam grade.

Info: Moodle + webpage <http://webpages.tuni.fi/rakmek/?id=6>

Lectures: Time table and content

Week 35, Aug. 25, Lecture 1. The general structure of mechanics. Mathematical preliminaries, tensor analysis, index notation. Stress (Lecture notes Ch. 1, 2.1-2.3)

Week 36, Sept. 1, Lecture 2. Stress (Ch. 2.4 - 2.8)

Week 37, Sept. 8, No lecture due to lecturer's conference trip.

Week 38, Sept. 15, Lecture 3. Equilibrium equations, state of strain (Ch. 3 and 4)

Week 39, Sept. 22, Lecture 4. Isotropic elastic material model (Ch. 5.2)

Week 40, Sept. 29, Lecture 5. Transversely isotropic elastic material model (Ch. 5.3)

Week 41, Oct. 6,, Lecture 6. Orthotropic elastic material model (Ch. 5.4)

Week 42, exam week.

Week 43, Oct. 20, Lecture 7. Plasticity - general behaviour + yield criteria (Ch. 6.1 and 6.2.1-6.2.2)

Week 44, Oct. 27, Lecture 8. Plasticity - yield criteria (cont'd) (Ch. 6.2.3-6.2.4)

Week 45, Nov. 3, Lecture 9. Plasticity - flow rule and hardening rule (Ch. 6.3 and 6.4)

Week 46, Nov. 10, Lecture 10. Continuum damage models (Ch. 7)

Week 47, Nov. 17, Lecture 11. Viscoelasticity (Ch. 8)

Week 48, Nov. 24, Lecture 12. Creep models, viscoplasticity, (Ch. 9 and 10)

Week 49, Dec. 1, Lecture 13. On numerical solution methods for material models.

I have usually asked some external visiting lecture which will be informed later.

Reference to the lecture note chapters are for the version dated 30.10.2025. I might update the notes time to time.

Exercises: Time table and content

Week 35, Aug. 26, Exercise 1. Mathematical preliminaries, tensor analysis, index notation.

Week 36, Sept. 2, Exercise 2. Stress (Ch. 2.1 - 2.8)

Week 37, Sept. 9, No exercise.

Week 38, Sept. 16, Exercise 2. State of strain (4)

Week 39, Sept. 23, Exercise 3. Isotropic elastic material model (Ch. 5.2)

Week 40, Sept. 30, Exercise 4. Transversely isotropic elastic material model (Ch. 5.3)

Week 41, Oct. 7, Exercise 5. Orthotropic elastic material model (Ch. 5.4)

Week 42, exam week.

Week 43, Oct. 21, Exercise 6. Plasticity - general behaviour + yield criteria (Ch. 6.1 and 6.2.1-6.2.2)

Week 44, Oct. 28, Exercise 7. Plasticity - yield criteria (cont'd) (Ch. 6.2.3-6.2.4)

Week 45, Nov. 4, Exercise 8. Plasticity - flow rule and hardening rule (Ch. 6.3 and 6.4)

Week 46, Nov. 11, Exercise 9. Continuum damage models (Ch. 7)

Week 47, Nov. 18, Exercise 10. Viscoelasticity (Ch. 8)

Week 48, Nov. 25, Exercise 11. Creep models, viscoplasticity, (Ch. 9 and 10)

Week 49, Dec. 2, Exercise 12. On numerical solution methods for material models.