# COURSE IN SOIL MODELING October 3rd to 7th, 2022

**Introduction:**

NTNU's Geotechnical Group offers a PhD Course in Soil Modelling from October 3rd to 7th, 2022.

**Background:**

This course provides a background for development and application of the soil models used in continuum-based computer codes for geotechnical applications. The course focuses on soil behaviour, elasto-plastic theory, hyper-plasticity, selected material models and their parameters. It also provides some insight into numerical implementation of soil models. The course aims at providing a general theoretical framework for interpretation of the mechanical behaviour of soils. A short summary of relevant continuum mechanics theory is given in the first lectures followed by a detailed presentation of simple models based on Tresca and Coulomb. The course introduces hyperplasticity, starting with principles of thermodynamics. The main principles of soil behaviour are discussed with emphasis on kinematic and isotropic distortional hardening in combination with dilatancy control. Further, models based on Critical State Soil Mechanics with volumetric hardening are covered, this also starting from a thermodynamic perspective using the framework of hyperplasticity. An introduction to more advanced models, including rate dependency, is given together with a discussion of current research topics. The course will be composed of intensive lecturing in combination with guided exercises during the week and homework assignments.

**Lecturers:**

Professor
Steinar Nordal
NTNU

Professor
Gustav Grimstad
NTNU

Researcher
Seyed Ali Ghoreishian Amiri
NTNU

**Target Audience:**

The course is at postgraduate/PhD level. It is based on a combined mathematical and graphical approach but is designed to give a platform for practical application in geotechnical design. The course does not require any background in finite element methods, but knowledge of conventional soil mechanics is a prerequisite. The course is taught in English.

**Exam and ECTS credits:**

The course is a registered PhD course at NTNU. A written exam is offered in December 2022. Candidates who complete the homework assignments handed out during the course are admitted to the exam. The course with exam gives 10 ECTS credits.

**Registration and fees:**

The total number of participants for the PhD course is limited. Registrations will be accepted in the order they are received. In order to get access to the exam, participants from outside NTNU must register as students at NTNU and, if they are not PhD candidates, pay a semester fee. PhD candidates only need to document their PhD status by contacting phd@ibm.ntnu.no.

**Course material:**

Lecture notes will be available as pdf.
The following textbook by Guy T. Houlsby and Alexander M. Puzrin is recommended:

- Principles of hyperplasticity: an approach to plasticity theory based on thermodynamic principles. Springer 2006.

**Preliminary Schedule**

***PhD course in Soil Modelling***

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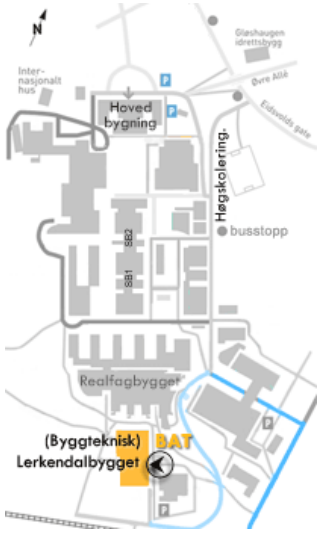
| Mon.<br>10:00 – 18:00 | BASIC CONCEPTS OF STRESS AND STRAIN TENSORS, ELASTICITY AND PLASTICITY<br>Stress invariants and yield criteria. Stress and strain measures. Elasticity. Elasto-plasticity, flow and hardening rules with the Tresca criterion as an example.<br>Exercises at the end of the day. |
| Tue.<br>8:15 – 18:00 | ELASTO PLASTICITY USING THE COULOMB CRITERION<br>Derivation and discussion of a simple isotropic hardening model for effective stress analysis.<br>Dilatancy and contractancy during distortional hardening controlled by a nonassociated flow rule.<br>Exercises at the end of the day. |
| Wed.<br>8:15 – 18:00 | INTRODUCTION TO HYPERPLASTICITY AND FRICTIONAL HARDENING<br>From principles of thermo-dynamics to hyperplasticity.<br>Derivation of the Mohr-Coulomb.<br>Extending to pre-failure nonlinearity and strength varying with density and stress level.<br>Exercises at the end of the day. |
| Thu.<br>8:15 – 18:00 | MODELS BASED ON VOLUMETRIC HARDENING<br>Cam Clay as a fully volumetric hardening model.<br>Adding rate dependency.<br>Exercises at the end of the day. |
| Fri.<br>8:15 – 16:00 | NUMERICAL IMPLEMENTATION<br>Implicit and explicit integration algorithms for soil models. Implementation in PLAXIS, or codes with a similar interface. "Hands on the computer" implementation exercise. |

**Physical venue:**

NTNU – Gløshaugen
Trondheim,
Norway.




**Contact and Registration**

For questions on course contents please contact Gustav Grimstad gustav.grimstad@ntnu.no.
For registration and all practical matters please contact Maren Berg Grimstad +47 73 59 20 18 maren.grimstad@ntnu.no

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