



# AGENDA

## iTOUGH2 Short Course

Lawrence Berkeley National Laboratory  
February 17–19, 2020

Instructor:

***Stefan Finsterle***  
Finsterle GeoConsulting

### Monday, February 17, 2020

9:00 am *Welcome*  
9:15 am *Introduction to inverse modeling*  
11:00 pm *iTOUGH2 input language*  
12:00 pm *Working Lunch*  
1:00 pm *Stochastic model*  
2:00 pm *Computer Exercise 1: Darcy*  
4:00 pm *Objective function*  
6:00 pm *Working Dinner (Location: TBD)*  
8:00 pm *Adjourn*

### Tuesday, February 18, 2020

9:00 am *Sensitivity analysis*  
10:30 am *Computer Exercise 2: Design of CO<sub>2</sub> well test*  
12:00 pm *Working Lunch*  
1:00 pm *Continuation Computer Exercise 2*  
2:00 pm *Minimization algorithm*  
4:00 pm *Continuation Computer Exercise 2*  
5:30 pm *Adjourn*

### Wednesday, February 19, 2020

9:00 am *Residual analysis*  
10:30 am *Uncertainty analysis*  
12:00 pm *Working Lunch*  
1:00 pm *Computer Exercise X / Darcy revisited*  
3:00 pm *Concluding remarks*  
3:30 pm *Adjourn*



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## Course Objectives

The training course provides the participants with the theoretical background and practical knowledge needed to solve inverse problems in geosciences and engineering. The lectures cover all aspects related to automatic model calibration using nonlinear parameter estimation methods, including sensitivity, data-worth, error and uncertainty propagation analyses. The lectures are complemented with computer exercises using the iTOUGH2 simulation-optimization code.

## Course Outline

The introductory lectures will discuss the process of parameter estimation by automatic calibration of numerical models used in geosciences. Parameterization of the forward model, selection of calibration data and their incorporation into an objective function are essential issues, as they determine whether a well-posed inverse problem can be formulated. Multiple optimization algorithms suitable to minimize the objective function will be presented. The need and usefulness of performing formal sensitivity, residual, error, and uncertainty analyses will be emphasized. In addition to the lectures, which provide the theoretical background, computer exercises using the iTOUGH2 simulation-optimization code will provide hands-on experience in solving practical inverse problems. Moreover, the course participants may be asked to work on a small project (either individually or in small groups), in which they formulate a tractable optimization problem and solve it using iTOUGH2. The combination of lectures, computer exercises, and project work will provide the attendees with solid knowledge in inverse modeling and initial experience in the use of iTOUGH2 for solving a variety of parameter estimation and optimization problems.

## Prerequisites

Understanding and experience in numerical simulation and modeling; good knowledge of the TOUGH2 nonisothermal multiphase flow simulator or completion of the TOUGH Beginner's Course.

## Course Material

Course attendees will be provided with hard copies of the lecture notes. Electronic copies of the lecture notes, all relevant manuals, as well as input files used during the course will be made available. The software will be made available for installation on the participants' laptop computers used during the Short Course. Course participants need a valid license to use the software after the course (see the Licensing tab at <http://tough.lbl.gov>).