001-2-2205: Modeling in the Earth Sciences (3 credits)

Weekly Lecture Hours	Exercise	Laboratory	Field Trip
3			

Lecturer: **Ido Regev**

***Course description and objective*:**
The goal will be to teach students from different backgrounds (soil physics, geology, environmental science and engineering) how to use mathematical tools to describe physical phenomena that occur in the soil and inside plants. The emphasis will be on understanding how to approach the problem of modeling a natural system and on solution methods. During the course we will also learn how to use MATLAB and Python (depending on student's preference) to solve the diffusion equation and other problems of interest.

Course prerequisites:
Basic courses in calculus and linear algebra.

Course structure:
The course will be taught weekly in 3 hours lectures.
The course is designed for M.Sc. students.

Assessment of students and structure of final grade:

Homework submission	25%
Final project	75%

Detailed description of course units:

1. Review of linear algebra and performing algebra in a computer

2. Differential Equations

3. Systems of differential equations – reaction dynamics

4. Gradients and fluxes

5. Introduction to fluid dynamics

6. Surface tension and capillarity

7. The diffusion equation

8. Solving the diffusion equation

9. Dimensional analysis

10. Numerical analysis

If there is enough time:

12. Probability and stochastic processes

13. Statistics and errors

14. Optimization and fitting

Suggested text books:

Holmes, Mark H. "Introduction to the foundations of applied mathematics", Vol. 56. Springer Science & Business Media, 2009.

King, Andy C. et al. "Differential equations: linear, nonlinear, ordinary, partial", Cambridge University Press, 2003.

Olver, Peter J. "Introduction to partial differential equations", springer, 2014.

De Gennes, Pierre-Gilles et al. "Capillarity and wetting phenomena: drops, bubbles, pearls, waves", Springer Science & Business Media, 2013.

Cleve Moler, Numerical Computing with MATLAB (https://www.mathworks.com/moler.html)

Gilbert Strang, Computational Science and Engineering, Vol. 1. Wellesley: Wellesley-Cambridge Press, 2007.