1. Introduction to the Course

1.1 Course Structure

The course is organized in two theoretical classes, plus one applied class per week but there will be no rigid distribution of the time between these two components. This will allow, if necessary, for extra time to complete the exercises in the classroom. Students are strongly encouraged to attend all classes, since there is a straight connection between the theoretical concepts and the practical exercises.

Classrooms have no computers, so students should bring their own laptops, if possible. This way, students can start the exercises in the classroom and keep working on the problems afterwards. Whenever the applied classes are too short to complete the exercises, students are expected to finish them as home work ($\approx$3 hours per week of extra work).

1.2 Course Content

The course is basically oriented around the following contents:

1. General introduction to numerical models;
2. Basics of how to develop a model;
3. When and how to apply a model;
4. Basic skills on how to evaluate a model.

In the introductory stage we will address some basic questions regarding the nature and usefulness of models. Some of these questions are: what is a model?, why use models in the first place?, how do I choose a particular model out of a set of models?, and, which model shall I use for a specific purpose? Finally, but not less important, we will address one of the fundamental question in the course: how is a model made?

Next, we will learn how to develop a model from scratch. In this section we will be following a stepwise approach, by starting with the choice of the type of model to built, then by drawing up a conceptual model, then attach a mathematical model to it and, finally, by constructing (or programming) a computer model.

After this stage we will engage in the use of modeling tools, both the models developed in the applied classes and available modeling packages. Here we will explore the dynamic nature of models and their ability to provide useful results in different environmental settings. In the process we will address the criteria to choose a particular model amongst a set of available and rather similar modeling tools.

Finally, we will learn how to evaluate a model. By starting with the choice of what type of evaluation is needed, we will then proceed to assess different options available to achieve that. This section will focus on graphical analysis (plots of the results) and quantitative analysis (calculate the accuracy of the simulation). More demanding approaches will also be analyzed, such as sensitivity analysis (examine the behavior of the model) and uncertainty analysis (determine the importance of model components).

1.3 Evaluation

The grading system will rely on three components: on-line quizzes made in the classroom, in-class exercises and homework assignments, and a final work. These will have a relative weight of 35%, 30% and 35%, respectively, on the final grade.

R Applied classes are hands-on. While attendance is not mandatory (there is no attendance control), students are strongly advised not to skip this classes. Quizzes, assignments and final work from students that don't attend classes can be declined, based on the assumption that elements of the group, other than the missing students, are responsible for the completion of the work.

1.4 Communication

Students are encouraged to have a pro-active communication with the teacher, either by email or directly at the office. Students should use this communication for comments or questions regarding course material, or to seek help to finish their in-class or homework assignments.

R Contact email: marcos.mateus@tecnico.ulisboa.pt

Email messages should include **MAmb2017** in the subject.

Gabinete 2.38 – Pav. Mecânica I

Office hours: Monday and Wednesday, 14h – 16h.

1.5 Additional resources

1.5.1 Bibliography

This course structure is based on the content of several environmental modeling manuals. These text books can and should be used as a source of additional information:

- *Environmental Modelling: An Introduction*, J. Smith & P. Smith, 2009, Oxford University Press.

- *Consider a Spherical Cow: A Course in Environmental Problem Solving*, J. Harte, 1988, University Science Books.
- *Environmental Modeling: A Practical Introduction*, M.J. Barnsley, 2007, CRC Press.
- *Surface Water-Quality Modeling*, S.C. Chapra, 1997, WCB McGraw-Hill.
- *Ecological Dynamics*, W.S.C. Gurney & R.M. Nisbet, 1998, Oxford University Press.

Besides this sources, a selection of papers will be handed out throughout the semester

1.5.2 Modeling software

There are numerous modeling software packages available today, varying in complexity, relevance, type of processes they address and, if applicable, in price. In our classes we will work with free software, whenever possible.

Throughout the semester we will be mostly using the following modeling tools:

- Stella: a visual programming language for system dynamics modeling;
- SWAT: a watershed model to simulate water dynamics (quantity and quality);
- CE-QUAL-W2: a water-quality and quantity model for lakes and reservoirs;
- MOHID Water: a hydrodynamic and water quality model for different type of water bodies (from rivers to open ocean).