UNIVERSIDAD DE MURCIA

FACULTY OF MATHEMATICS

Modeling Laboratory

Syllabus

Course code:	1597
Number of ECTS credits:	6
Semester:	2nd (February-June)
Prerequisites:	Students must have completed 60 credits of the so-called *basic courses*, as well as other 36 credits of compulsory (non-eligible) courses
Recommended components:	Ordinary Differential equations (1584) Functions of one variable I (1568) and II (1573) Linear Optimization (1582) Graphs and Discrete Optimization (1592)
Language of instruction:	Spanish (students are allowed to ask questions and write homeworks and exams in English)

Course description

The main goal of this course is to enable students to model problems of other sciences, using mathematical techniques, provide a solution (albeit approximate) and check and interpret the obtained solution.

Although there will be a moderate number of theoretical lectures, most of the classes are practical and given in computer rooms. Using a number of concrete models, shown by the teacher, a number of hands-on projects will be offered to students as individual and group projects. Models will be grouped according to their modeling classification: discrete time models, continuous time models, optimization models, stochastic models, etc.

The clear practical approach to this course and the active role required from the student (we focus on developing modeling competencies more than on introducing new mathematical content), makes this a project-based course. In the course, students need to work on the projects by themselves, under the guidance of instructors. For this reason, the presence of the student is greater than in other courses.

Learning outcomes and competences

After completion of this course you will:

1. Be able to identify and describe in mathematical terms a problem of other sciences, structure the available information, and select an appropriated mathematical model.

2. Analyze and solve in an exact or approximated form simple mathematical models.

3. Contrast the solution of a problem, obtained using a given mathematical model, in terms of how well it fits the real data of a problem.

4. Use different scientific software to solve problems modeled with algebraical or differential equations, system of equations, optimization, curve fitting or other mathematical techniques.

Course contents

I. Introduction to Modeling

1. Introduction to Modeling.
   Objectives of modeling. Steps in the process of modeling. Classification of models. Formulation of models. Implementation of models.

II. Discrete and Continuous Models

1. Discrete Models.
   Formulation of discrete models. Models based on recurrences. Models with analytic solution. Probabilistic models. Celular automata.
2. Continuous models.
   Models based on ordinary differential equations. Hybrid models: differential equations with events. Models based on delay differential equations. Models based of partial differential equations.

III. Optimization

1. Review of optimization problems.
   Linear optimization. Integer linear programming. Network optimization. Nonlinear programming.
2. Project management
   Activity networks. CPM. PERT.
3. Goal programming
   Multiobjective models. Efficient solutions. Introduction to goal programming. Weighted method. Lexicographic method. Minimax method.

IV. Simulation

1. Introduction to simulation.
   Simulation - basic concepts. (Pseudo-) random numbers - generator. Approximation to series and integrals.
2. Simulation of probability distributions.
   General discrete-variables simulation methods. General continuous-variables simulation methods. Methods specific for popular probability distributions.
3. Discrete events simulations.

References

Main texts

1. Esquembre, F. *Creación de simulaciones interactivas en Java*; Pearson Educación, 2005
2. Romero, C. *Técnicas de programación y control de proyectos*; Ed. Pirámide, 2000.
3. Romero, C. *Teoría de la decisión multicriterio: Conceptos, técnicas y aplicaciones*; Alianza Editorial, 1993

4. Ross, S.M. *Simulation (2nd ed.)*; Academic Press, 1996

5. Shiflet, A. B. ; Shiflet, G . W. *Introduction to computational science: Modeling and simulation for the sciences*; Princeton University Press, 2006.

Supplementary references

1. Bank; J. (ed.) *Handbook of Simulation*; John Wiley and Sons, INC. 1998

2. Danby; J.M.A. *Computer Modeling: From Sports to Spaceflight, from Order to Chaos*; Atlantic Books, 1999.

3. Librería digital ComPADRE de modelos físicos y de astronomía *http://www.compadre.org/osp* (Consultada en 2014).

4. Williams, H.P. *Model building in Mathematical Programming*; John Wiley and Sons, 1993.