

Faculty: Science and Technology

Course: **Numerical Methods**

Programme: Study Abroad in Engineering

Semester: 1 - Fall

ECTS credits: 6

Duration: 45 hours

Language of instruction: English

Instructor: Rafel Martí Serra

### **Course Description**

The aim of this Course is to understand the numerical methods that may be used once analytic methods are not enough. The course includes solving non-linear equations, interpolation, numerical differentiation and integration, and differential equations

### **Prerequisites**

None

### **Attendance policy**

Attendance is mandatory for all classes, including study visits. Any exams, tests, presentations, or other work missed due to student absences can only be rescheduled in cases of certified medical or family emergencies.

### **Learning outcomes**

By the end of the course, students should be able to use numerical methods both by hand and with a computer and apply them successfully to any problem related to the subject.

### **Method of presentation**

- Lectures and discussions: Lectures with appropriate visual support provide the theoretical content of the sessions. Class discussions facilitate the students' ability to connect reading and lectures, analyzing or applying concepts.
- Class participation: Students are expected to participate in group activities and in the discussions based on the course readings and cases proposed.

- Home exercises: Students are expected to solve several exercises about each chapter during the semester.

### Required work and assessment methods

Cases, reading and exercises. Preparation and development related to exercises will be highly valuable for the success of the course both at individual and group level.

Participation Individual active participation in discussions and team work. The positive and proactive attitude of the student will be encouraged and valued by instructors throughout the course.

In order to pass the course, it is compulsory to have completed all the exercises proposed by the teacher. These exercises will count for 60% of the final qualification. The remaining 40% will be the average of the exams taken during the course. The final exam of the subject will be held on December 19th.

### Activities weight. Ordinary evaluation.

	Practice U2	Practice U3	Practice U4	Practice U5	Exam
%	15	15	15	15	40

Students who do not pass the course will be able to make it up with a final exam of the whole course syllabus after the Christmas holidays. In this case, the final mark will be a 5.

### Contents

#### Unit One: The error ( 1 week )

#### Unit Two: Solutions of Equations in One Variable (3 weeks approx.)

- The Bisection Method.
- Fixed-Point Iteration.
- Newton's Method.

#### Unit Three: Interpolation and Polynomial Approximation (3 weeks approx.)

- Interpolation. Lagrange Polynomials.
- Divided Differences.
- Hermite Interpolation.
- Cubic Spline Interpolation.

#### Unit Four: Numerical Differentiation and Integration ( 4 weeks approx.)

- Numerical Differentiation.
- Numerical Integration: the Trapezoidal Rule.
- Numerical Integration: Simpson's Rule.
- Gaussian Quadrature.

#### Unit Five: Initial-Value Problems for Ordinary Differential Equations ( 4 weeks approx.)

- Euler's Method. Higher-Order Taylor Methods.
- Runge-Kutta Methods.
- Systems of Differential Equations. Higher-Order Equations.

### **Recommended reading**

**Basic:** R.L. Burden, J.D. Faires: Numerical Analysis (9th Ed.). Brooks/Cole.

**Complementary:** J.F. Epperson: An Introduction to Numerical Methods and Analysis (2nd Ed.). Wiley.

W. Gautschi: Numerical Analysis (2nd Ed.). Birkhäuser.