Manifesto of studies

Courses outline

The School organizes several courses to be attended by the students on the basis of their individual syllabus.

Institutional courses at DICAM, a.y. 2012/2013

N.B. the schedule may be changed, please ask the secretariat or check on the website

Period	Course	Professor
First term: January - April 2013		
14-18 Jan.	Ecology and environmental chemistry	M. Ragazzi
Jan. 21-Feb. 1	Advanced numerical methods for free-surface hydrodynamics	V. Casulli
Jan. 21-Feb. 1	Sustainable housing	A. Frattari
Feb. 4 -19	Local environmental sustainability	C. Diamantini
Jan. or Feb.	Architectural design: form and scale of contemporary project	C. Battaino
February 4-15	Advanced numerical methods for hyperbolic equations and applications	E. Toro
Feb. 18- March 1	Mathematical methods for engineering	A. Valli
March 11-15	Environmental data management and analysis with GIS	P. Zatelli
Second term: May - September 2013		
	Energy performance of buildings	P. Baggio
	Experimental techniques	P. Baggio
June 10-14	Geostatistics	A. Bellin
June-July	Fluid mechanics (Padua)	M. Tubino
Sept.	Spatial multicriteria analysis for environmental decision-making	D. Geneletti

Other courses (Language and transferable skills)

Period	Course	Seat
February - March	Technical-Scientific English	Eng. Faculty
March-April	Crash course on Intellectual property and Research funding	Research office

Institutional courses will be activated if a minimum of 3 students will be enrolled. Should this number not be achieved, the course will be activated in the subsequent academic year.

All details and changes regarding the timetable and rooms will be published on the website at the following page: http://www.unitn.it/dree

Courses details and programmes

Ecology and environmental chemistry

M. Ragazzi, G. Andreottola, and E.C. Rada (h. 24) > ECTS 3

N.B. It is useful to carry a calculation machine.

Programme

1. Nutrient cycles, transport (phenomena) kinetics, other basics.
2. Lake pollution: theory of eutrophication.
3. Lake pollution: external and internal interventions.
4. Basics of air pollution and health risk.
5. Air pollution and prevention.
6. Air pollution and treatment.
7. Respirometry applied to wastewater
8. Respirometry applied to biodegradable waste
9. Biochemical processes for biodegradable waste

Tutorials
Tutorials and exercises are integrated in the lectures.

Assessment
The test consists in a written short report on one topic chosen by the student among the subjects proposed by the professors.

Advanced numerical methods for free-surface hydrodynamics

V. Casulli and M. Dumbser (h. 40 + 20) > ECTS 5

Programme

1. Mathematical Models
1.1 The Navier-Stokes Equations
1.2 A Three-Dimensional Hydrostatic Model
1.3 The Vertically Averaged Model (2Dxy)
1.4 The Laterally Averaged Model (2Dxz)
1.5 The Open Channel Equations (1D)

2. Eulerian-Lagrangian Methods
2.1 Advection-Diffusion Equations
2.2 Explicit Central Difference Method
2.3 Implicit Central Difference Method
2.4 Explicit Upwind Method
2.5 Implicit Upwind Method
2.6 Eulerian-Lagrangian Methods
2.7 Semi-Implicit Methods
2.8 The Conjugate Gradient Method

3. Numerical Methods for the 1D Model
3.1 Characteristic Analysis
3.2 A Semi-Implicit Finite Difference Method
3.3 An Equation for the Free Surface

4. Numerical Methods for the 2Dxz Model
4.1 A Semi-Implicit Finite Difference Method
4.2 Derivation of the Free Surface Equation
4.3 A Particular Case: The 1D Model

5. Numerical Methods for the 2Dxy Model
5.1 Characteristic Analysis
5.2 A Semi-Implicit Finite Difference Method
5.3 An Equation for the Free Surface
5.4 A Particular Case: The 1D Model

6. Numerical Methods for the 3D Model
6.1 Extensions of the 2D Methods
6.2 A Semi-Implicit Finite Difference Method
6.3 An Equation for the Free Surface
6.4 A Particular Case: The 2Dxy Model
6.5 A Particular Case: The 2Dxz Model

7. Further Extensions
7.1 The θ-Method
7.1.1 A Semi-Implicit Finite Difference Method
7.1.2 Solution Algorithm
7.2 Numerical Modelling on Unstructured Grids
7.2.1 Orthogonal Unstructured Grid
7.2.2 A Semi-Implicit Discretization
7.2.3 Solution Algorithm

7.3 Semi-Implicit Subgrid Modelling
7.3.1 Semi-Implicit Finite Volume Discretization
7.3.2 Solution Algorithm

Laboratory Exercise:

- With MATLAB, the participants will implement a semi-implicit finite difference scheme using an Eulerian-Lagrangian approach for the convection terms for the open channel equations (1D) as well as for the vertically averaged model (2Dxy).
- A new rigorous treatment for wetting and drying, which is a very frequent problem in civil and environmental engineering, is also part of the laboratory exercises.

Assessment
The test consists of a presentation on a topic chosen by the student among the subjects of the course.

References
Lecture notes from the instructor.

Sustainable housing

A. Frattari, R. Albatici (h. 32) > ECTS 4

Programme

1. The environmental sustainability and the sustainability in the architecture: principles, definition of the eco-sustainable architecture, natural materials and technologies
2. Thermal and acoustic comfort of the interior; rational use of the natural resources as wind, water, sun, etc.
3. Learning visits of building sites and of specialized exhibitions
4. The use of the wood and the timber in the building constructions: the use in the past, at present time, development of the research in this field
5. Design and building technology for passive and low energy buildings
6. Passive building elements for heating, cooling and ventilation of living spaces

Tutorials
Tutorials and exercises are integrated in the lectures.

Assessment
The test consists of a colloquium on one topic chosen by the student among the subjects of the course.

Local environmental sustainability

C. Diamantini, B. Zanon, D. Vettorato (h. 36) > ECTS 4

Course Description
The course lays the foundation to the concept of environmental sustainability, by providing key definitions of environmental factors and components, and describing how they interact with human systems. An overview of the most pressing environmental problems is presented, by discussing their effects on human well-being, possible responses and open challenges. Finally, the concept of human-environment system, as a fundamental paradigm to address sustainability challenges and propose solutions, is presented and illustrated through case studies.

Detailed course content

- Earth's life support systems: environmental factors, components, and their interaction (3 h)
- Global environmental outlook: overview of current and emerging challenges (3 h)
- Human-environment systems: concepts and examples from the global to the local scale (6 h)
- Environmental sustainability: key concepts (3 h)
- The measure of sustainability: environmental indicators and indices (3 h)
- Implementing environmental sustainability at local level: past and current actions (6 h)
- Case studies (12 h)

Assessment
The assessment consists of the review of a scientific article related to the topics of the course.

Architectural design: form and scale of contemporary project

C. Battaino (h. 30) > ECTS 4

Programme

- Spatiality of antithesis: the new key-words of project in the complex contemporary landscapes
- Architecture of relations: the new dimensions of project in the territorial city.
- Architecture of the stratification: refused landscapes like palimpsest of the project. The modern military architectures unused.
- Laboratory of architectural design.

Tutorials
Tutorials and exercises are integrated in the laboratory.

Assessment
The test consists in a written test about the subjects of the course.

Reference
Claudia Battaino, *Forti, architettura e progetti*, Nicolodi, Rovereto 2006
Claudia Battaino, *Progetto per la penisola di Cavallino nella laguna di Venezia*, Gorizia 2004
Marco Mulazzani, *Luigi Moretti. Works and writings*, Princeton Architectural Press, New York 2002 (with Federico Bucci)

Advanced numerical methods for hyperbolic equations and applications

E.F. Toro and M. Dumbser (h. 40 + 20) > ECTS 5

Programme

Week 1
Theoretical aspects of hyperbolic conservation laws. Review of basic numerical concepts for hyperbolic equations. Finite volume methods for one-dimensional systems. Godunov's method. The Riemann problem for linear systems. The Riemann problem for the shallow water equations. Approximate Riemann solvers. Godunov-type finite volume methods for non-linear systems. Centred numerical fluxes. Construction of higher order non-oscillatory methods via non-linear schemes: TVD, ENO and WENO reconstruction procedures. Discontinuous Galerkin Finite Element methods for one-dimensional problems. Robust and accurate discretization of source terms: stiff and nonstiff cases. The well-balanced property and numerical methods for non-conservative hyperbolic systems. Extension to multiple space dimensions.

Week 2
The second week is dedicated to the extension of the methods introduced in the first week to complex geometries using unstructured triangular meshes in two space dimensions and using mesh-free approaches.

- **Mesh-based algorithms**: unstructured meshes for two-dimensional geometries. High-order reconstruction on unstructured meshes in multiple space dimensions. High Order Finite volume and discontinuous Galerkin finite element methods on unstructured meshes. Applications to the shallow water equations and the Euler equations of compressible gas dynamics.
- **Mesh-free algorithms**: introduction to particle methods. Guidelines for implementation of smooth particle hydrodynamics (SPH) based on the Riemann solvers introduced in the first week.
- **High performance computing**: parallelization of the above-mentioned methods using the MPI (Message Passing Interface) standard.

At the end of the second week, the course is rounded-off by advanced seminar-style lectures with outlooks on the following topics: extension to 3D tetrahedral meshes, compressible multi-phase flows, electromagnetic, acoustic and seismic wave propagation.

Tutorials
20 hours of tutorials in the computing laboratory are part of the course. These are designed to provide hands-on experience by using some sample computer programs (prof. Dumbser).

Assessment

Open-book examination to be handed one week after the end of the course**,** followed by an oral discussion on the questions. For the test students must answer 3 questions.

References

E. F. Toro (1999). *Riemann Solvers and Numerical Methods for Fluid Dynamics*, 2nd ed., Springer Verlag.
E. F. Toro (2001). *Shock-Capturing Methods for Free-Surface Shallow Flows*, Wiley and Sons.

Mathematical methods for engineering

A. Valli and A.M. Alonso Rodriguez (h. 50) > ECTS 4

Programme

1. **Separation of variables**
   - 1.1. Heat equation in one space variable.
   - 1.2. Wave equations in one space variable.
   - 1.3. Complete orthonormal basis and related Fourier expansion.
   - 1.4. Sturm-Liouville problems for second order linear symmetric elliptic operators.

2. **Fundamental solutions and Green functions**
   - 2.1. Concentrated unit impulse.
   - 2.2. Fundamental solution of a linear operator L.
   - 2.3. Fundamental solution of the Laplace operator in two and three variables.
   - 2.4. Green function in a bounded domain.

3. **Integral equations and the boundary element method**
   - 3.1. Singular integrals.
   - 3.2. Green formulae.
   - 3.3. Integral equation for the Dirichlet boundary datum.
   - 3.4. Boundary element method: general considerations.

4. **Weak formulation and the finite element method**
   - 4.1. Weak formulation of second order linear elliptic boundary value problems.
   - 4.2. Minimization problems in the calculus of variations.
   - 4.3. Lax-Milgram lemma and its consequences.
   - 4.4. Galerkin approximation method.
   - 4.5. The finite element method.

Tutorials

A minimum number of 9 hrs is foreseen for tutorials and exercises (dr. Alonso).

Assessment

The test consists in a colloquium on one topic chosen by the student among the subjects of the course.

References

C.C. Mei, *Mathematical Analysis in Engineering*, Cambridge University Press, 1995 (Selected subjects from Chapters 2, 3 and 6).
F. Paris and J. Cañas, *Boundary Element Method*, Oxford University Press, 1997 (Selected subjects from Chapters 1-3).
A. Quarteroni and A. Valli, *Numerical Approximation of Partial Differential Equations*, Springer 1997 (2nd printing) (Selected subjects from Chapters 3, 5-9).

Environmental data management and analysis with GIS

P. Zatelli, M. Ciolli, and A. Vitti (h. 30) > ECTS 3

Programme

1. Introduction to GIS and numerical cartography.
2. Cartographic projections, reference systems and their transformations
3. GIS theory, tools and data.
4. Digital geographic data sources.
5. GRASS GIS: features, logical structure and usage.
6. Overview of GIS applications.
7. Geoprocessing, network analysis and WebGIS.
8. Spatial databases, theory, tools and data.
9. Image analysis for environmental applications.
10. GIS and geostatistics.
11. Tutorial on environmental GIS applications.

Tutorials
Tutorials and exercises are integrated in the lectures.

Assessment
The test consists in performing and explaining a part of the GIS procedures of the GRASS tutorial.

Energy performance of buildings

P. Baggio (h. 20) > ECTS 3

Programme

1. Overview of the building role in the global energy consumption perspective. The directive 2002/91/EC of the European parliament and of the council of 16 December 2002 on the energy performance of buildings
2. Introduction to the energy balance at the building level: transmission and ventilation losses, solar heat gains, storage of heat in, or release of stored heat from, the mass of the building, primary energy need for the heating (and/or cooling) system.
3. Introduction to the new European standards for the evaluation of the thermal performance of buildings: UNI EN 832, UNI EN ISO 13790, prEN iSO 13790; outline of the calculation procedures and rules for the energy balance of building and systems. Different types of calculation methods (seasonal vs. monthly vs hourly)
4. Design guidelines for energy efficient buildings: opaque building elements, windows, thermal bridges. Solar heat sources exploitation: passive strategies vs. active systems. From the design drawings to the actual building: problems arising in the construction yard.
5. Thermal performance of buildings in the summer season: introduction to the analysis and the calculation of the cooling load. Design guidelines: thermal capacity vs. thermal insulation
6. How to communicate the energy value of a building to the laymen, how to ensure regular maintenance and regular inspection of boilers and of air-conditioning systems: the ENERGY CERTIFICATION of buildings as an approach to ensure lasting energy performance.
7. Some examples of existing energy certification rating systems (Trento, Bolzano, Vicenza). Interaction of the energy certification with the building codes. Minimum and quality requirements of the energy certificate as an instrument to steer the building practices.

Tutorials
Tutorials and exercises are integrated in the lectures.

Assessment
The test consists in a short written test about the subjects of the course.

Reference
European Directive and UNI EN ISO standards (available at the Engineering faculty library)

Experimental techniques

P. Baggio, A. Vitti, M. Righetti, M. Ragazzi (h. 24) > ECTS 3

Programme

<u>Basics of metrology, measurement methods and thermometry</u>
(prof. P. Baggio)

1. Basics of metrology.
2. Outline of measurement methods (data detection /acquisition/gathering, response of sensors, calibration, etc.).
3. Basics of thermometry and temperature scale ITS90.
4. Survey of the main temperature sensors and their features.
5. Laboratory exercise on the calibration of some temperature sensors.

<u>Detection, representation and computerized management of land data</u>
(prof. G.B. Benciolini)

6. Basics of issues connected with Reference Systems.
7. Main detection methods: a comparative survey, use contexts, and accuracy achievable.
8. Basics of photogrammetric detection, with a simple example project.
9. Basics of GPS detection, with a simple example project.
10. Cartography: contents, projections, Italian cartography.
11. GPS instruments exercise.
12. Geographic Information Systems: basics, potentiality, and applications.
13. Data processing (basic controls) in GRASS system.

14. Laboratory exercise on GRASS system.

Laser Doppler Anemometry
(eng. M. Righetti)
15. Basics of laser Doppler anemometry.
16. Laboratory exercise.

Exercise (measurements) at the Hydraulics Laboratory
17. Measurement of pressure, rate of flow, velocity and load cells.

Tutorials
Tutorials and exercises are integrated in the lectures.

Assessment
The test consists in a practical application of one topic chosen by the student among the subjects of the course.

Geostatistics

A. Bellin and B. Majone (h. 18 + 14) > ECTS 4

Programme
1. Introduction (2 h)
1.1 What is Geostatistics?
1.2 Descriptive and inferential statistics;
1.3 How to describe spatial variability;
1.4 Correlation;
1.5 Stationarity;

2. Geostatistical analysis of spatial data (4 h+4 h)
2.1 Introductory data analysis
2.2 Spatial structure of data (regional variables)
2.3 Structural analysis (the intrinsic model)
2.4 Covariance functions
2.5 Semivariograms
2.6 Experimental semivariogram
2.7 Inference of the spatial model
2.8 Exercises

3. Geostatistical interpolation (8 h + 6 h)
3.1 The Kriging paradigm
3.2 Ordinary and Simple Kriging
3.3 Factorial Kriging
3.4 Estimating the error
3.5 Including secondary information
Kriging within strata
Kriging with an external drift
Kriging with variable means
Co-located Kriging
Cokriging
3.6 MultiGaussian approach to local uncertainty
3.7 Indicator Kriging and related methods
3.8 How to use local uncertainty models
3.9 Exercises

4. Stochastic models: applications (4 h + 4 h)
4.1 Interpolation versus stochastic modeling (random field generators)
4.2 Generation of unconditional random fields
4.3 Generation of random field conditioned to the measurements
4.4 Exercises

Tutorials
The course is structured in lectures (18 h) followed by exercises and applications (14 h)

Assessment
The test is a seminar on a paper of interest to the student and approved by the instructors.

Fluid mechanics

M. Tubino et alii (36 h.) > ECTS 4

The definitive programme will be published on the website.

Spatial multicriteria analysis for environmental decision-making

D. Geneletti > ECTS 3

Programme
Environmental decision-making involves the identification and comparison of different alternatives based on multiple objectives and criteria. This calls for a framework to integrate factual information on effects and impacts, with values and preferences of stakeholders. Multicriteria analysis (MCA) offers such a framework, and it is increasingly used in combination with GIS (spatial multicriteria analysis, SMCA).
This course provides the essential principles of MCA and SMCA applied to environmental decision-making, and covers the following topics:

- Basic concepts of decision theory and problem structuring
- The philosophy of (S)MCA for environmental decisions
- Methodological steps in MCA and SMCA (value function and weight assessment, criteria aggregation, sensitivity analysis, result presentation)
- Using Decision Support Systems (DSS) and GIS-based DSS
- Application examples in different domains.

The teaching method is based on theoretical lectures and hands-on exercises, using freely available software packages. The expected learning outcomes include:

- Understanding the advantages and limitations (S)MCA
- Familiarizing with different methods and techniques
- Acquiring skills in DSS and GIS-based DSS
- Understanding the role played by technical experts, stakeholders and decision-makers
- Gaining first-hand experience in real-life case studies

Assessment
The test consists of the review of a scientific article about the topics of the course.

Other courses (Language and transferable skills)

Scientific-Technical English for Engineers

F. Hope (24 h.) > ECTS 3

This English course, specifically organized for the doctoral students in scientific subjects, is compulsory.

Programme

Text structure
- Biodata statements
- Problem-solution texts
- Abstracts – types and structure
- Structure of introductions to articles

Grammar of written academic English (Science and Engineering):
- Formal academic grammar
- Use of articles (the, a, uncount, generic references)
- Noun phrases – identifying, awareness of importance
  - gerund or noun? – cline of impersonality
  - the…of vs noun + noun
  - creating compound nouns and Noun Phrases
  - hyphens in Noun phrases
  - making simpler NP's using Prep Phr).
- Reduced relative clauses
- Defining v non-defining relative clauses
- Participles
  - participle clauses
  - position of participles (the solution used or the used solution)
- Hedging of claims
- 'this' v 'it'
- Cohesion with 'this'

- Position of adverbs
- -ing clauses of result
- Indirect questions
- Language issues arising from students' work

Presentations:

- phrases for interrupting the speaker
- phrases to signal new topics
- checking understanding
- discussion of presentation techniques
- student presentations and feedback
- common pronunciation problems

Crash course on Intellectual Property and Research funding

Research central office (h. 24) > ECTS 2

Programme

Subjects
Patenting and Intellectual property. Focus on biomedical inventions
Research in Europe, 7° framework program and beyond: trans-national calls, ERA-NET calls and other opportunities
Copyright and protection of research results
Spin-off/start-up foundation and business planning
Researcher's mobility and Marie Curie actions in the 7° Framework Programme

Assessment

Multiple choice test