University of Padova
School of Science

CATALOGUE OF COURSE UNITS HELD IN ENGLISH

FOR ERASMUS, FOREIGN AND ITALIAN STUDENTS

academic year 2014 > 2015
FOR COURSES BASED ON A SEMESTER ORGANIZATION
First semester: October 1st, 2014 to January 24th, 2015
Winter exams session: January 26th, 2015 to February 28th, 2015
Second semester: March 2nd, 2015 to June 12th, 2015
Summer exams session: June 15th, 2015 to July 25th, 2015
Extra exams session: August 24th, 2015 to September 23th 2015

First-cycle degree = Bachelor degree
Second-cycle degree = Master degree
ERASMUS SECOND-CYCLE DEGREES

1. ASTROMUNDUS
www.astro.unipd.it/astromundus
2. ALGANT
   (Algebra, Geometry And Number Theory)
   http://lauree.math.unipd.it/algant/node/4

SECOND-CYCLE DEGREES WITH A PROGRAM OF COOPERATION WITH OTHER EUROPEAN UNIVERSITIES FOR COMMON DEGREES

An agreement between the University of Padova and the French Universities Paris Diderot-Paris 7 and Paris Descartes. has been established since the academic year 2010-11 for the release of a common degree between the Second-cycle degree in Molecular Biology and the Master de Sciences Santé et Application.

This project requires the mobility of students (up to 6 per year) within the ERASMUS program. More information is available on http://biologia-molecolare.biologia.unipd.it/organizzazione-ccs/socrates-erasmus/

Academic year 2014 > 2015
<table>
<thead>
<tr>
<th>Index</th>
<th>Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADVANCED CORPORATE FINANCE</td>
<td>COMPUTER SECURITY</td>
</tr>
<tr>
<td>ADVANCED OPTOMETRY AND CONTATTOLOGY</td>
<td>COSMOLOGY</td>
</tr>
<tr>
<td>ALGEBRAIC GEOMETRY 1</td>
<td>CRYPTOGRAPHY</td>
</tr>
<tr>
<td>ALGEBRAIC GEOMETRY 2</td>
<td>DATA ANALYSIS</td>
</tr>
<tr>
<td>APPLIED GEOCHEMISTRY</td>
<td>ELECTROCHEMISTRY</td>
</tr>
<tr>
<td>APPLIED PETROGRAPHY</td>
<td>ENVIRONMENTAL BIOTECHNOLOGY AND BIOENERGY PRODUCTION</td>
</tr>
<tr>
<td>ASTRONOMICAL SPECTROSCOPY</td>
<td>ENVIRONMENTAL CHEMISTRY AND GENETIC TOXICOLOGY</td>
</tr>
<tr>
<td>ASTROPHYSICS 2 (ALSO OFFERED AS THEORETICAL ASTROPHYSICS IN THE</td>
<td>ENVIRONMENTAL IMPACT AND LIFE CYCLE ASSESSMENT</td>
</tr>
<tr>
<td>SECOND-CYCLE DEGREE IN ASTRONOMY)</td>
<td>ENVIRONMENTAL IMPACT ASSESSMENT</td>
</tr>
<tr>
<td>BASIN ANALYSIS</td>
<td>ENVIRONMENTAL MINERALOGY</td>
</tr>
<tr>
<td>BIOCHEMISTRY</td>
<td>ETHOLOGY</td>
</tr>
<tr>
<td>BIODIVERSITY AND BEHAVIOR</td>
<td>EVOLUTION AND CONSERVATION</td>
</tr>
<tr>
<td>BIOINFORMATICS</td>
<td>FUNCTION THEORY</td>
</tr>
<tr>
<td>BIOPOLYMERS</td>
<td>FUNCTIONAL ANALYSIS 2</td>
</tr>
<tr>
<td>CELESTIAL MECHANICS</td>
<td>FUNCTIONS OF SEVERAL COMPLEX VARIABLES</td>
</tr>
<tr>
<td>CHEMISTRY OF ORGANIC MATERIALS</td>
<td>GALAXY DYNAMICS</td>
</tr>
<tr>
<td>COMMUTATIVE ALGEBRA</td>
<td>GENETIC DISEASES AND MODEL SYSTEMS</td>
</tr>
<tr>
<td>COMPLEX ANALYSIS</td>
<td>GENOMICS</td>
</tr>
<tr>
<td>COMPUTATIONAL FINANCE</td>
<td>HIGH ENERGY ASTROPHYSICS</td>
</tr>
<tr>
<td>COMPUTATIONAL METHODS IN MATERIALS SCIENCE</td>
<td>HUMAN PHYSIOLOGY</td>
</tr>
<tr>
<td></td>
<td>IMMUNOLOGICAL BIOTECHNOLOGY</td>
</tr>
</tbody>
</table>
ADVANCED CORPORATE FINANCE

Second-cycle degree in Statistical Sciences
Language: English
Teaching period: first semester
Lecturer: Giacomo Boesso
Credits: 8 CFU/ECTS

Prerequisites
Business Administration or Introduction to Business
Basic Financial Accounting

Programme
Trend and market analysis
Definition of the value proposition
Demand analysis
Offer analysis
Operative analysis
Risk analysis
Financial and Economic feasibility
Value analysis
Scenarios analysis
Social Sustainability

Examination
Individual and group assignments.

More information

ADVANCED OPTOMETRY AND CONTACTOLOGY

First-cycle degree in Optics and Optometry
Language: English
Teaching period: second semester
Lecturer: Marino Formenti
Credits: 6 CFU/ECTS

Programme
Behavioral Optometry
Philosophy
The behavioral approach to vision care
The optometric visual analysis: classical vs behavioral visual exam

Vision and Stress
Nearpoint visual demands
Autonomic visual response to stress agents
Organism Stress response
Stress response in the visual function
Symptoms and signs of visual stress
Development of refractive errors and visual dysfunctions in response to visual stress

Optometric Evaluation of learning problems
Developing learning readiness
Learning related vision problems
Visuo-perceptual-motor optometric evaluation

Myopia Control
Refraction in worldwide pediatric population
Myopia and environment
Effect of urbanization
Concept and importance of peripheral refraction
Optic defocus theory and philosophy: central vs peripheral vision
Studies in laboratory animals
New concepts in ophthalmic and contact lenses designs for myopia control
Spectacles lens design
Soft lenses: Aspheric, Multifocals

Rigid Gas Permeable: a dynamic application of the sagittal philosophy
ALGEBRAIC GEOMETRY 1

Second-cycle degree in Mathematics
Language: English
Teaching period: second semester
Lecturer: Bruno Chiarellotto
Credits: 8 CFU/ECTS

Prerequisites
Basic commutative algebra and basic geometry of the first 3 years in math.

Programme
The aim of the course is to introduce the language of schemes connected with classical algebraic geometry. We will introduce Projective and affine varieties, relation with commutative algebra, Blow ups. Schemes and sheaves. The topological notion translated in this setting: separateness, properness, smoothness. An introduction to some invariants.

Examination
Written.

More information

Design
Spherical
Aspherical
Multifocal
Reverse Geometry
Toric

Orthokeratology
History of orthokeratology
Daily wear orthokeratology
Overnight orthokeratology
Orthokeratology design
Corneal changes
How it works
Guidelines and protocol

More information
**ALGEBRAIC GEOMETRY 2**

Second-cycle degree in Mathematics  
Language: English  
Teaching period: second semester  
Lecturer: Matteo Longo, Marco Andrea Garuti  
Credits: 6 CFU/ECTS

**Prerequisites**  
Galois theory; Commutative algebra. Students are not required to have already taken Algebraic Geometry 1, but it is assumed that are following that course.

**Programme**  
The aim of the course is to give an introduction to the Galois theory of homogeneous linear differential equations. This theory goes back to the 19th century and parallels the Galois theory for algebraic field extensions. It studies the (usually non-algebraic) extensions obtained by adding to a function or power series field a full set of solutions of a differential equation. The notions of splitting field of a polynomial, Galois group and solvability by radicals have their counterpart in the notions of Picard-Vessiot extension, differential Galois group and solvability by quadratures. The differential Galois group of a homogeneous differential equation is a linear algebraic group, carrying both the structure of an algebraic variety and a group law given by algebraic functions.

**Examination**  
Written.

**More information**  

---

**APPLIED GEOCHEMISTRY**

Second-cycle degree in Geology and technical Geology  
Language: English  
Teaching period: first semester  
Lecturer: Christine Marie Meyzen  
Credits: 6 CFU/ECTS

**Prerequisites**  
All students must have a basic knowledge of geochemistry, geology, mineralogy and petrography.

**Programme**  
This course is intended to provide the student with an understanding of the main geochemical interaction processes among the various Earth's geochemical reservoirs (lithosphere, pedosphere, biosphere, hydrosphere and atmosphere) by exploring their impacts on various environmental reservoirs and their induced effects on ecosystems and health of living beings. A special emphasis will be placed on how anthropogenic activities disturb these chemical interactions on Earth. Specifically, we will examine the sources, reactions, transport, effects, and fates of chemical species in air, water, and soil environments, and the effects of technology thereon. Environmental issues that will be discussed include climate change, air and water pollution. Analytical methods and their limits - Geochemical modeling - Biogeochemical cycles - Composition and quality of natural waters and their main classification schemes - Chemical and mineralogical transformations during weathering processes - Chemistry and properties of soils - Chemical composition of the atmosphere - Chemical elements as proxies of the pollution of surface water bodies and groundwater, soils and atmosphere (ozone, greenhouse effect, water pollution by heavy metals) - Mapping and geochemical sampling.

At the end of the course, students will be able to:  
- Understand the natural geochemical cycles of elements at the surface of the Earth, as well as the
effects of human activities upon these cycles.
- Understand the processes involved in the
distribution and transport of chemical substances
between the atmospheric, continental and marine
environments.
- Reflect on the interactions among chemical,
geological, physical and biological environmental
processes.
- Interpret environmental geochemical data sets.

**Examination**
Written and oral.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/
SC1180/2009/000ZZ/1109906

---

**APPLIED PETROGRAPHY**

Second-cycle degree in Geology and technical
Geology
Language: English
Teaching period: first semester
Lecturer: Claudio Mazzoli
Credits: 6 CFU/ECTS

**Programme**
This course examines in depth application
aspects of petrography with reference to
the following arguments: physical-chemical
properties and decay of natural ornamental
and dimension stones; traditional ceramic
materials; hydraulic and non-hydraulic binders;
applications to archaeometry.

**Examination**
Oral.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/
SC1180/2009/000ZZ/1096159
Prerequisites
Basic Physics I and II, Calculus I and II, Atomic Physics, Astrophysics I - II.

Programme
Radiation in the interstellar gas: definition of radiative terms; transfer equation; local thermodynamic equilibrium; equivalent thermodynamic equilibrium. Emission and absorption lines in the interstellar environment: emission and absorption coefficients; statistic equilibrium; collisional processes and kinetic temperature; excitation in interstellar conditions; forbidden lines; recombination lines; intensity of lines as a function of density and temperature. Continuum emission and absorption processes: free-free transitions; intensity of the thermal radio continuum; bound-free and free-bound transitions; synchrotron radiation. Ionization: ionization equilibrium; ionization of hydrogen; HII regions; ionization of helium; dust extinction; HI regions; ionization of the heaviest elements. Formation and dissociation of interstellar molecules: molecular hydrogen; CO, OH, H2O in diffuse nebulae; molecules in dense nebulae. Thermal equilibrium and kinetic temperature of gas: Equation of thermal equilibrium; heating and cooling processes of gas; thermal equilibrium of HII regions; thermal state of HI regions.

Examination
Oral.

More information
ASTROPHYSICS 2 (also offered as Theoretical Astrophysics in the Second-cycle degree in Astronomy)

First-cycle degree in Astronomy
Language: English
Teaching period: second semester
Lecturer: Paola Marigo
Credits: 6 CFU/ECTS

Prerequisites
Elements of plane trigonometry, derivatives, integrals, basic knowledge of physics relating to previous courses.
Preparatory courses: Astronomy I (two years) and Astronomy II (model A, third year).

Programme
1. Introduction and overview.
   Observational constraints, the H-R diagram, mass-luminosity and mass-radius relations, stellar populations and abundances.
2. Hydrostatics, energetics and timescales.
5. Nuclear reactions.
   Nuclear energy generation (binding energy).

Derivation of thermonuclear reaction rates (cross sections, tunnel effect, Gamow peak).
Temperature dependence of reaction rates.
   Overview, time/space derivatives, limiting cases. Boundary conditions and their effect on stellar structure. How to obtain solutions.
7. Simple stellar models.
   Polytrophic models. Homology relations: principles, derivations, application to contraction and the main sequence. Stability of stars: derivation of simplified criteria for dynamical and secular stability.
8. Schematic evolution from the virial theorem (VT).
   Evolution of the stellar center combining the VT and the EoS: evolution tracks in terms of (P,rho) and (T,rho). Evolution towards degeneracy or not. The Chandrasekhar mass, low-mass vs massive stars. Critical ignition masses, brown dwarfs, nuclear burning cycles.
9. Detailed evolution: towards and on the main sequence.
   Simple derivation of Hayashi line, pre-MS evolution tracks properties of the ZAMS: M-L and M-R relations, occurrence of convection zones evolution across the MS band: structural changes, low-mass vs high-mass, effects of overshooting.
10. Post-MS evolution.
11. Late evolution of low- and intermediate-mass stars.
    The Asymptotic Giant Branch: thermal pulses, 2nd/3rd dredge-up, mass loss, nucleo-synthesis. White dwarfs: structure, non-ideal effects, derivation of simple cooling theory.
12. Pre-SN evolution of massive stars.
    Importance of mass loss across the HRD (O stars, RSG, LBV and WR stars). Modern evolution tracks. Advanced evolution of the core: nuclear burning cycles and neutrino losses, acceleration of core evolution. Pre-SN structure.

**Examination**
Oral.

**More information**

---

**BASIN ANALYSIS**

Second-cycle degree in Geology and technical Geology
Language: English
Teaching period: second semester
Lecturer: Massimiliano Zattin
Credits: 6 CFU/ECTS

**Prerequisites**
Basic knowledge of some courses of the first semester (Applied geophysics, Micropaleontology, Applied geochemistry).

**Programme**
The course is intended to cover modern concepts of tectonics and analysis of sedimentary basins through the illustration of geodynamic systems involving basin development. After a first view of classification schemes, basics and mechanics of basins formation will be therefore described in their plate tectonic environment and according to the geodynamic regime: rifts and passive continental margins, orogenic wedges and lithospheric buckling, strike-slip settings. The different topics will be illustrated through many examples from around the world. The course will include a review of key analytical techniques for a quantitative approach with a focus on burial history analysis.

**Examination**
Written.

**More information**
BIOCHEMISTRY

Second-cycle degree in Molecular Biology
Language: English
Teaching period: first semester
Lecturer: Ildiko Szabó
Credits: 8 CFU/ECTS

Prerequisites
Basic level of biochemistry, cellular biology and physiology.

Programme
Exercise in class room: Journal club, virtual research program
Laboratory exercise: purification and biochemical characterization of a membrane protein (preparation of thylakoids, membrane solubilization, alkaline extraction, treatment with protease, SDS-PAGE, Western blot).

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1175/2008/000ZZ/1109364

BIODIVERSITY AND BEHAVIOR

Second-cycle degree in Marine Biology
Language: English
Teaching period: second semester
Lecturer: Matteo Griggio
Credits: 8 CFU/ECTS

Prerequisites
To successfully follow this course, it is desirable that the student has taken courses in ecology, and in particular in marine ecology, at different levels (population, community).

Programme
Biodiversity: the concept of biodiversity, the diversity of organisms and the ecological systems in which they live. The key role of evolution in shaping biodiversity. Ecological pressures on the morphology and behaviour of marine species. Morphological and behavioural adaptations to different marine habitats (pelagic, benthic, abyssal, intertidal). Biodiversity as the web of complex interrelationships between organisms, the contribution of the study of animal behaviour to understanding the concept of biodiversity. The study of reproductive behaviour, parental care, mimicry and social life, using the most modern concepts of behavioural ecology. Anthropic pressures on marine species and marine habitats. Anthropic impacts on marine species behaviour.

Examination
Written.

More Information
http://en.didattica.unipd.it/offerta/2014/SC/IF0360/2013/000ZZ/1095955
**BIOINFORMATICS**

Second-cycle degree in Computer Science  
Language: English  
Teaching period: first semester  
Lecturer: Giorgio Valle  
Credits: 6 CFU/ECTS

**Prerequisites**
There are no particular prerequisites other than what it is expected from a master student in informatics. However, a basic knowledge of genetics and molecular biology will help in the understanding of the biological motivations of bioinformatics.

**Programme**
The course is divided in three main parts. The first part is an extensive introduction on Biology presented as a scientific field centered on Information. The mechanisms that facilitate the transmission and evolution of biological information is be used to introduce some biological issues that require computational approaches. The second part of the course describes the main algorithms used for the alignment of biological sequences, including those designed for “next generation sequencing”. The algorithms used for de novo genomic assembly are also described. Finally, the third part of the course covers several aspects of bioinformatics related to functional genomics, such as the analysis of transcription, gene prediction and annotation, the search of patterns and motifs and the prediction of protein structures. The role of Bioinformatics in individual genomic analysis and personalized medicine is also discussed.

**Examination**
Oral.

**More information**

---

**BIOPOLYMERS**

Second-cycle degree in Industrial Chemistry  
Language: English  
Teaching period: first semester  
Lecturer: Stefano Mammi  
Credits: 6 CFU/ECTS

**Prerequisites**
None.

**Programme**
The course describes in general terms the study of structural properties of biological macromolecules, such as polypeptides and proteins, polynucleotides, and polysaccharides. The course is divided into three parts: in the first one, the structural properties of natural and synthetic biopolymers are described and discussed while the second describes some industrial applications of artificial and natural biopolymers and biocompatible and/or biodegradable polymers; finally, the main methods for the study of conformations, interactions and conformational transitions of biopolymers are considered in the third part.

**Examination**
Oral.

**More information**
CELESTIAL MECHANICS

Second-cycle degree in Astronomy
Language: English
Teaching period: second semester
Lecturer: Stefano Casotto
Credits: 6 CFU/ECTS

Programme
1. The equations of motion of a system of N bodies - Symmetries and first integrals - Reference frames
2. The Two-Body Problem - The conic section solutions and their representations - Regularization and formulation in universal variables
3. Computation of an ephemeris
5. Relative Keplerian motion - Rendez-vous - Orbital maneuvers
6. Lambert’s theorem - Lambert targeting
7. The Three-Body Problem - Homographic solutions
8. The Circular Restricted Three-Body Problem - The Jacobi integral - Zero velocity surfaces - Periodic orbits

Examination
Oral.

More information

CHEMISTRY OF ORGANIC MATERIALS

Second-cycle degree in Chemistry
Language: English
Teaching period: second semester
Lecturer: Enzo Menna
Credits: 6 CFU/ECTS

Prerequisites
General Organic Chemistry.

Programme
The course program covers main application fields for advanced organic materials. Each application will be discussed with regard to: theoretical bases required to understand how the material works, different chemical classes, different kind of structures, synthesis and characterization, structure-property relationships, device fabrication techniques, examples of application. The following topics will be considered: Fullerenes, nanotubes and other carbon nanostructures, Organic photovoltaic devices, Organic electroluminescent materials (OLED), Self assembled layers of organic molecules, Molecules for non-linear optics, Biomimetic materials, Structural organic materials (main classes of plastic and engineering polymers, their application, synthesis and properties).

Examination
Oral.

More Information
http://en.didattica.unipd.it/offerta/2014/SC/SC1169/2013/000ZZ/1116186
Second-cycle degree in Mathematics  
Language: English  
Teaching period: first semester  
Lecturer: Marco Andrea Garuti  
Credits: 8 CFU/ECTS

Prerequisites
Basic notions of algebra (rings, ideals, fields, quotients, etc.), as acquired in the class “Algebra 1”.

Programme

Examination
Written.

More information
COMPLEX ANALYSIS
Second-cycle degree in Mathematics
Language: English
Teaching period: second semester
Lecturer: Andrea D’Agnolo
Credits: 6 CFU/ECTS

Prerequisites
undergraduate courses in Calculus and Geometry
elementary notions on complex functions of one
complex variable. In particular:
Cauchy-Riemann identities and complex
differentiation; holomorphic functions. Line
integrals of complex functions and their
homotopy invariance. Logarithm of a path and
winding number. Cauchy formula for a circle.
Analiticity of holomorphic functions. Zero-set
of a holomorphic function; the identity theorem.
Open mapping theorem. Laurent series and
isolated singularities. Residue theorem, and its
use for the computation of integrals. Argument
principle.

Programme
The argument principle and applications. The
Schwarz reflection principle. Conformal maps
and the Riemann Mapping theorem. Runge’s
theory and applications. Mittag-Leffler’s
theorem and elliptic functions. The Weierstrass
factorization theorem. Principal ideals of
holomorphic functions. Some special functions
(Gamma, Zeta). The Prime Number theorem

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/
SC1172/2011/001PD/1109778

COMPUTATIONAL FINANCE
Second-cycle degree in Statistical Sciences
Language: English
Teaching period: first semester
Lecturer: Massimiliano Caporin
Credits: 9 CFU/ECTS

Prerequisites
Elements of Economics and Mathematics of
Financial Markets, elements of Statistics and
Econometrics. Knowledge of the mean-variance
approach of Markowitz, of the CAPM and APT
models, and of the pricing of derivatives with
binomial trees and with the Black and Scholes
model.

Programme
Part 1: The formalization of computational
problems into a statistical package
- Introduction to the software; data management;
basic tools for descriptive and graphical analyses;
- Basic data manipulation tools; using already
implemented functions;
- Basic programming and how to write a batch file
for execution;
- Introduction to simulation methods: simulations
from a given density; resampling/bootstrap from
historical series; model-based bootstrap;
- Further elements will be introduced during the
course, when needed.

Part 2: Asset Allocation
- The classic approach, Markowitz’s world: the
efficient frontier with and without the risk-free
asset and its empirical evaluation;
- Markowitz in realistic applications: no short
selling constraints, linear constraints, turnover
constraints, inequality constraints, probabilistic
constraints, cardinality constraints; empirical
elements; the need of non-standard optimization
approaches (mixed quadratic-integer
programming and genetic algorithms);
- The use of Markowitz in asset allocation
programs and for strategic asset allocation;
- Beyond Markowitz: from mean-variance, to mean-VaR; the optimization of alternative criterion functions; higher order portfolio allocation, is it worth? the modern approach of Risk Budgeting, implementation and examples; the information content of extreme market moves in the computation of the mean-variance matrix (the Chow-Kritzmann approach); is the historic efficient frontier fully reliable/the unique solution? Michaud's simulation-based approach to the computation (and rebalancing) of efficient portfolios;
- Investing for the long run: returns predictability and mean reversion; identification of optimal portfolios and simulation of wealth paths;

Part 3: Risk Management and performance evaluation
- The construction of simulated track records in allocation programs; methods and indicators for portfolio monitoring and performance evaluation; portfolio turnover and portfolios costs;
- Indicators for the evaluation of portfolio risk (market risk, credit risk, systemic risk); some notes on operational risk;
- The VaR and ES as methods for the evaluation of market risk; computing VaR and ES for one single position and at the portfolio level; historical approaches, model-based methods, simulation approaches, the use of copula functions;
- Portfolio exposure to risk-factors: single-index and multifactor models; conditional factor models; models for market timing; VaR with risk-factors;

Part 4: Pricing of derivatives and interest rates
- Pricing in Black & Scholes world; replicating Black & Scholes by simulation; pricing of selected exotic options;
- Pricing by simulation and time-series model-based methods;
- Estimation of the interest rate zero curve by bootstrapping.

The program might be subject to changes depending on a number of elements including: the interest of the students and their ability to solve computational problems with the statistical software; the occurrence of particular events in the financial markets. Changes to the program content will affect the list of tasks included in the team work.

The program above refers to both the main module and the second module of the course.

For students in the degree of Statistics, the topics covered in the main module will be detailed at the beginning of the course. The second module will deal with the following topics:
- Introduction to financial instruments and markets;
- Investment choices under uncertainty and the approach of Markowitz;
- Market equilibrium, CAPM and APT, and market efficiency;
- Derivative pricing in discrete and continuous time.

**Examination**
Group homework.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/SS1736/2014/000ZZ/1111478
**COMPUTATIONAL METHODS IN MATERIALS SCIENCE**

Second-cycle degree in Materials Science  
Language: English  
Teaching period: second semester  
Lecturer: Francesco Ancillotto/ Alberta Ferrarini  
Credits: 6 CFU/ECTS

**Prerequisites**  
Quantum and solid state physics, physical chemistry.

**Programme**  
Basic concepts of thermodynamics and classical statistical mechanics. Classical Molecular Dynamics simulations; numerical integration of Newton equations. Monte Carlo method; Metropolis algorithm. Simulations in various statistical ensembles. Common features of simulations methods: initial and boundary conditions; calculation of inter-particle interactions. Calculation of thermodynamic and transport properties. Intermolecular interactions: force-fields; atomistic and coarse grained models. Variational methods for the solution of the Schrodinger equation. Hartree and Hartree-Fock theory. Elements of Density Functional Theory (DFT). ‘First principles’ simulations. The different computational methods will be discussed in relation their application to topics of interest for material science (crystals, surfaces, soft matter, nanostructured materials). In the computer exercises, students will carry out simple simulations, using software packages that are currently employed in materials science, and they will learn how to interpret and present the results of simulations.

**Examination**  
Oral examination in which the students will discuss a written report, on the results of simple numerical simulations

**More information**  
http://en.didattica.unipd.it/offerta/2014/SC/SC1174/2013/000ZZ/1116660

---

**COMPUTER SECURITY**

Second-cycle degree in Computer Science  
Language: English  
Teaching period: second semester  
Lecturer: Mauro Conti  
Credits: 6 CFU/ECTS

**Prerequisites**  
Basic knowledge of distributed systems, cryptography and network security.

**Programme**  
- ADVANCED TOPICS based on a selection of scientific papers that either have had a strong impact on security today, or explore novel ideas that may be important in the future.

**Examination**  
Oral.

**More information**  
Programme

1. The Large Scale Structure of the Universe.
   Local properties.
   General and structural properties of the universe. Large scale distribution of galaxies.
   Power-spectrum of the cosmic structures.
   Relationship of the power-spectrum and $\xi(r)$.
   Observational data on the large scale structure. The initial power-spectrum of the perturbations.
   3D mapping of galaxies, clusters, AGNs.
   Counts-in-cells. Outline of fractal and topological analyses of the universe.

2. The Homogeneous and Isotropic Universe.
   Hubble law. The Cosmological Principle.
   Generalized dynamical equations. The cosmological constant. Observational evidences

3. Deviations from homogeneity and isotropy.
   Gravitational lensing
   Point-like lenses and isothermal spherical distributions. Lens potentials. Einstein radius.
   Lensing cross-sections. Lensing effects on time lags, Caustics. Observations of the gravitational
   lensing and cosmological applications. Estimate of the total galaxy cluster mass. Estimates of $H_0$.
   Effects of a cosmological constant $\Lambda$ in the lensing statistics.

4. Perturbations in an expanding universe.
   Peculiar motions of galaxies and structures.
   Constraints on the cosmological parameters from the large scale motions.

5. Brief thermal history of the Universe
   Cosmic entropy per barion.
   Primordial nucleo-synthesis.

6. The Cosmic Microwave Background
   Discovery of the CMB. Observations from ground and from space. COBE & WMAP.
   Origin of the CMB.
   Spatial properties, isotropy of the CMB.
   Statistical description of the angular structure.
   Origin of the CMB angular fluctuations.
   Physical processes in operation on the large scales. Fluctuations on intermediate angular scales. Contributions of sources to the anisotropies on small scales.
   Constraints of CMB observations on the cosmological parameters.
   The CMB spectrum. Spectral distortions.
   The Sunyaev-Zeldovich effect. Observational limits on the spectral distortions and their implications.

7. The Primordial Universe, Big Bang, phase transitions, cosmological inflation
   The problem of the cosmological horizons.
   Propagation of the information and visibility of the universe.
   Big Bang singularity. Planck time.
   Overview of the standard model of elementary particles. Fundamental interactions.
   Cosmological phase transitions and their
epochs.

8. The Post-Recombination Universe
Cosmological evolution of galaxies and active galactic nuclei.
Evolutionary history of star formation and production of heavy elements. Contributions to the background radiations.
Intergalactic diffuse gas. Absorption-lines in quasar spectra, Lyman-alpha clouds. The missing baryon problem.

Examination
Oral.

More information

CRYPTOGRAPHY

Second-cycle degree in Computer Science
Language: English
Teaching period: first semester
Lecturer: Alessandro Languasco
Credits: 6 CFU/ECTS

Prerequisites
The topics of the following courses: Algebra, Calculus and Algorithms (especially for computational complexities estimates).

Programme

Examination
Written.

More information
DATA ANALYSIS
Second-cycle degree in Statistical Sciences
Language: English
Teaching period: first semester
Lecturer: Monica Chiogna
Credits: 9 CFU/ECTS

Prerequisites
Basic Mathematics (undergraduate level).
It would be advantageous to have some background knowledge of elementary Probability Theory.

Programme
Part 1: Statistical Methods (6ECTS)
• Visualization: plots including histograms, box plots, scatterplots, scatterplot matrices, etc.
• Summary statistics and goodness-of-fit tests. One- and two-sample examples, t and F distributions.
• Concepts of simulation: simple simulation experiments.
• Linear regression, including multiple linear regression. Associated inference problems. Regression diagnostics. Classical approaches to ANOVA. Model selection.
• Logistic regression and Poisson regression.
• Introduction to the design of experiments, observational studies and sampling methods.
Part 2: Applied Multivariate Techniques (3ECTS)
• Dimension reduction
• Classification
• Clustering

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SS1736/2014/000ZZ/1111774

ELECTROCHEMISTRY
Second-cycle degree in Chemistry
Language: English
Teaching period: first semester
Lecturer: Flavio Maran
Credits: 6 CFU/ECTS

Prerequisites
B.Sc. level knowledge of Physical Chemistry, Organic Chemistry, and Analytical Chemistry

Programme
Electrochemistry is described from a detailed description of the equilibrium and transport properties of the phases forming the electrochemical systems. Electrochemical kinetics in terms of electron transfer, mass transport, and associated chemical reactions as the rate determining steps. Main electrochemical methods, such as chronoamperometry, cyclic voltammetry and rotating-disk electrode voltammetry, with emphasis on highlighting the above principles and the type of electrode response to the possible rate-determining regimes. Effect of electrode size. Main scanning electrochemical methods, where tiny conductive probes are used to study and/or modify surfaces.

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1169/2013/000ZZ/1098833
Prerequisites
No specific prerequisites.

Programme

Bioenergy:
Introduction; current energy sources and the necessity of researching renewable fuels.
The production of bioethanol from lignocellulosic biomasses; production of biodiesel from oleaginous crops.
The biotechnological challenges for biofuels production: the optimization of conversion of solar into chemical energy.

Examination: Oral, discussion on the subject starting from a recent literature paper.

More information
agents. Toxicological databases and genetic activity profiles. Spontaneous and induced mutagenesis, dynamic mutations. RNA and protein damage. Effects of non-ionizing and ionizing radiations from the molecular events to late consequences; adaptive response, bystander effects, genetic/epigenetic mechanisms of genomic instability. In vitro and in vivo assays for studying action mechanism and exposure to toxic agents (practical examples and laboratory experiences). Reporter genes and mutation spectra, toxicogenomics (approach and examples).

**Examination**
Oral.

**More information**

---

**ENVIRONMENTAL IMPACT AND LIFE CYCLE ASSESSMENT**
Second-cycle degree in Statistical Sciences
Language: English
Teaching period: second semester
Lecturer: Luca Palmeri
Credits: 6 CFU/ECTS

**Programme**
The course is centered on the environmental impact assessment procedure. In particular the following topics are addressed: legislation (European and national), the administrative practice, the environmental impact study document writing and the tools for the evaluation of impacts. Several other closely related topics are discussed too: the strategic environmental evaluation, incidence evaluation and the integrated pollution prevention and control. After an introduction to the general theory of decision making and of decision support systems, the principal evaluation tools are presented, e.g. multi-criteria analysis, risk analysis and life cycle assessment. Applications to real case studies are foreseen along the entire duration of the course in order to clarify the theoretical subjects presented.

**Examination**
Oral.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/SS1736/2014/000ZZ/1111755
ENVIRONMENTAL IMPACT ASSESSMENT
Second-cycle degree in Natural Science
Language: English
Teaching period: second semester
Lecturer: Massimo De Marchi
Credits: 6 CFU/ECTS

Prerequisites
Ecology and environmental law.

Programme
Objectives
To provide the students with the basic theory and practice for conducting the principal procedures for environmental evaluations
A student who has met the objective of the course will be able:
To know Environmental Impact Assessment (EIA) and Strategic Impact Assessment (SEA) procedures
To know the main legislative and regulatory dispositions at national and international levels (UE, UNECE, USA, Italian Legislation and some regional legislation)
To handle the preparation of the Environmental Impact Statement under EIA procedure and Environmental Report under the SEA procedure
To deal with the impact on biodiversity under Habitat Directive and the assessment of implications
To manage tools for environmental assessment
To manage tools for participation management under environmental evaluation procedures

Program
The role and need for evaluation
Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA): regulations, procedures, case studies, European and International comparisons
Art. 6 of Habitat directive and assessment of implications on Natura 2000 sites: procedures and case studies
Landscape and Visual Impact Assessment:

Examination
Working group report plus oral examination.

More information
Programme
Aims: The course will introduce the fundamental concepts of the mineralogy and the petrology of Earth's crust materials, as a base to characterize and interpret natural and anthropogenic processes having environmental implications. The program will encompass several case-studies. Each case will be discussed under the point of view of the analytical and instrumental problems, of the physico-chemical mechanisms, and of the interpretative methodologies of the processes.

Programme:
- Natural solid materials: basic concepts of mineralogy and petrology.
- Natural processes. Introduction on the distribution of the chemical elements on the Earth's crust, on the geological processes, on the geochemical cycles. Processes and fluid-solid interactions at the mineral surfaces. Experimental techniques to study materials surfaces.

Case studies:
- (1) Hazardous minerals in nature and in working places: asbestos, free silica. Environmental monitoring, assessment, mineral quantification, disposal.
- (2) Microporous minerals: clays, zeolites. Crystal structure, crystal chemistry, absorption properties, ionic exchange properties, catalysis. Their use in environmental and industrial applications.
- (3) Mineral dust. Origin, characterization. Implications for the palaeoclimatic and environmental reconstructions of the investigations of mineral dust entrapped in polar ice.

- (4) Metals and the environment. Dispersion and re-mobilization of toxic elements during mineral deposits exploitation. Acid mine drainage. The case of arsenic dispersion: inorganic vs bio-controlled processes. The topics will be shown and discussed with the aid of specific scientific literature.

Teaching aids:
- web notes and material (http://www.geoscienze.unipd.it/studenti/artioli/HTC/index.html)
- issues of the journal “Elements” (http://www.elementsmagazine.org/index.htm)

Examination
The final examination will include an oral colloquium on the course programme and a student's seminar on a specific topic selected among those discussed during the course and integrated by specific readings.

More information
### Ethology

**Second-cycle degree in Evolutionary Biology**  
**Language:** English  
**Teaching period:** second semester  
**Lecturer:** Andrea Augusto Pilastro  
**Credits:** 6 CFU/ECTS

**Prerequisites**  
Good knowledge in evolutionary biology, ecology, genetics, and zoology (advanced undergraduate course level).

**Programme**  
This course introduces the students to the scientific study of the behavior of animals. Providing a theoretical framework, illustrated with numerous examples, all aspects of animal behavior are discussed. Students will be encouraged to think about the evolutionary origin and adaptive significance of behavior. Main topics will regard the link between animal behavior ecology and evolution, the development and control of behavior: genes environment and neural mechanisms, the evolution of animal signals, adaptive responses to predators, foraging behavior and optimality models, reproductive behavior: male and female tactics, mating systems, parental care, sperm competition and sexual selection, sexual conflict, social behavior, kin selection.

**Examination**  
Written (multiple choice questions, open questions).

**More Information**  

### Evolution and Conservation

**Second-cycle degree in Evolutionary Biology**  
**Language:** English  
**Teaching period:** first semester  
**Lecturer:** Andrea Pilastro  
**Credits:** 6 CFU/ECTS

**Prerequisites**  
Good knowledge in evolutionary biology, ecology, genetics, zoology and botany (advanced undergraduate course level).

**Programme**  
The course will focus on genetic and evolutionary applications to the problems of conservation, while reflecting the diversity of concerns that are relevant to conservation biology. Particular emphasis will be put on themes like measures of phylogenetic diversity and uniqueness, population genetic structure of natural and managed populations including the identification of ‘evolutionary significant units’ and ‘management units’ for conservation, assessment of levels of genetic variation within species and populations, assessments of the effect of sexual selection mate choice and reproductive strategy on population conservation, forensic applications, methods for maximizing genetic diversity during captive breeding programs and re-introduction schemes, effect of anthropogenic factors on evolutionary adaptation to local changes in the environment.

**Examination**  
Evaluation based on written exam. Oral test possible if required by the student (please contact the teacher in advance).

**More Information**  
FUNCTION THEORY

Second-cycle degree in Mathematics
Language: English
Teaching period: first semester
Lecturer: Pierdomenico Lamberti
Credits: 8 CFU/ECTS

Prerequisites
Measure Theory and Lebesgue integration: basic definitions, classical theorems for passing to the limit under integral sign, Tonelli and Fubini Theorems, basic notions on $L^p$ spaces.

Programme

Examination
Written + oral.

More information

FUNCTIONAL ANALYSIS 2

Second-cycle degree in Mathematics
Language: English
Teaching period: first semester
Lecturer: Massimo Lanza De Cristoforis
Credits: 8 CFU/ECTS

Prerequisites
Analysis courses of the first two years and preferably also Real analysis, Mathematical methods, Functional analysis 1.

Programme

Examination
Partial tests and final oral exam.

More information
FUNCTIONS OF SEVERAL COMPLEX VARIABLES
Second-cycle degree in Mathematics
Language: English
Teaching period: first semester
Lecturer: Giuseppe Zampieri
Credits: 6 CFU/ECTS

Prerequisites
Basics on functions of one complex variable, differential calculus, differential geometry.

Programme
1. Real and complex differentials
2. Cauchy formula on polydiscs
3. Subharmonic functions
4. Separate analytic functions
5. Analytic functions and convergent power series
6. Levi form and H. Lewy’s extension theorem
7. Logarithmic Superharmonicity, Continuity principle, Propagation of holomorphic extendibility
8. Domains of holomorphy and pseudoconvex domains
9. L2 estimates and Neumann problem

Examination
Oral.

More information

GALAXY DYNAMICS
First-cycle degree in Astrophysics
Language: English
Teaching period: second semester
Lecturer: Giuseppe Galletta
Credits: 6 CFU/ECTS

Prerequisites
A basic knowledge of Astrophysical concepts about stars and galaxies from previous courses of Astronomy. Basic elements of Astrophysics, Structure of the Matter, Theoretical physics.

Programme
These lectures are composed by two sections: a theoretical one (3 CFU/ECTS) and a practical one (3 CFU/ECTS)
Theory on galaxy dynamics:
The cosmological framework: birth of modern cosmology.
Cosmological Principles; Einstein’s equations (by analogy), Robertson-Walker metric. Friedmann’s Equations, Einstein’s and de Sitter’s solutions.
Crucial phases of the cosmological evolution; Jeans instability, Bonnor reformulation, role of dark matter; spherical collapse of a density perturbation.
Structures on galaxy mass scales in the CDM scenario and their phases before virialization.
The thermodynamic perspective: entropy and information; violent relaxation mechanism in phase-space; Landau-damping and virialization.
Stress tensor and anisotropies of peculiar velocities in the dynamics of stellar systems.
The Fundamental Plane of galaxies and the scale relationships. Theoretical interpretations.
Weak homology. The tensor virial theorem for one and two-component system. The Clausius virial: tidal energy and interaction energy.
Connection with the cosmological scenarios.
The cosmic meta-plane.
Observations of galaxy dynamics:

**Examination**
Oral exam or, if requested by the most part of the students, written exam (five questions with open-length answer).

**More information**

---

**GENETIC DISEASES AND MODEL SYSTEMS**
Second-cycle degree in Molecular Biology Language: English Teaching period: first semester Lecturer: Mauro Agostino Zordan Credits: 4 CFU/ECTS

**Prerequisites**
The course consists in a series of specific seminars dealing with the general topic of genetic diseases and the model organisms employed to study the molecular mechanisms involved in the physiopathology of the diseases. Consequently, all of the courses entailed by the Master’s degree are considered preparatory to this course.

**Programme**
The course is organized as a series of one-hour seminars on topics dealing mainly with genetic diseases and the use of model organisms in genetic disease research. Topics typically touch upon molecular aspects of select genetic diseases and on the application of models such as in vitro mammalian cells, yeast, Drosophila, zebrafish and mouse to study the pathogenetic mechanisms of specific genetic defects. Generally the course activity consists in 12 seminars, which are held during an intensive one-week period.

**Examination**
The final exam will be written and consists in reading a scientific paper dealing with the subject exposed in one of the seminars and, on the basis of the paper’s content, writing an abstract, which for the occasion, will have been concealed from the original paper.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/SC1175/2008/000ZZ/1100293
GENOMICS

Second-cycle degree in Molecular Biology
Language: English
Teaching period: second semester
Lecturer: Giorgio Valle
Credits: 9 CFU/ECTS

Prerequisites
The content of the course has been defined keeping in mind the program of the first level degree in Molecular Biology of the University of Padua. In particular it is expected that the students have a good knowledge of Genetics, Molecular Biology and Bioinformatics.

Programme
Presentation of course and practicals
Introduction: Life, Biology, Information, Genomes, Evolution
History of genomics
Next Generation sequencing (NGS)
NGS: data formats for reads
Classical sequence alignment and assembly algorithms
NGS read alignment
Alignment formats: gff, sam and bam
Genome assembly with NGS data
Mate pair libraries and scaffolding
Metagenomics

Part 2
Transcriptome: Northern, EST, Full length, Microarrays
RNAseq
Analysis of RNAseq data
Proteomics
miRNA,
miRNA target prediction; lincRNA
Interactomics, and functional associations
Gene prediction, gene ontology and gene annotation
DNA methylation and methylome analysis
Histone modification and ChIP analysis

Part 3
Analysis of human mutations and polymorphisms
GWAS
Genome re-sequencing and Exome sequencing
Personalized medicine and related bioinformatics
Genome browser
Data integration and systems biology
General summary, discussion and conclusions

Examination
Oral.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1175/2008/000ZZ/1109368
**HIGH ENERGY ASTROPHYSICS**

Second-cycle degree in Astronomy  
Language: English  
Teaching period: second semester  
Lecturer: Piero Benvenuti  
Credits: 6 CFU/ECTS

**Programme**  
The course is aimed at providing the student with a basic knowledge of the physics of plasma with particular attention to the astrophysical plasmas.

**Content**  
Definition of plasma – Plasmas in astrophysics  
– Observational data – Different theoretical approaches.  
Recalls of dynamics of fluids – Magnetohydrodynamics (MHD).  
Waves in plasma fluids – Non linear steepening and shocks – Instabilities.  
Collisions – Collisionless plasmas  
Cosmic Rays – Fermi acceleration – Shock acceleration  
Astrophysical dynamos  
Magnetic reconnection  
MHD flows in compact astrophysical objects

**Examination**  
Oral.

**More information**  

---

**HUMAN PHYSIOLOGY**

Second-cycle degree in Sanitary Biology  
Language: English  
Teaching period: first semester  
Lecturer: Luigi Bubacco  
Credits: 9 CFU/ECTS

**Prerequisites**  
Biochemistry and General Physiology.

**Programme**  
The Central Nervous System (8 hours)  
Neurons: Cellular and Network organization and Properties,  
Efferent Division: (10 hours) Autonomic and Somatic Motor Control. Sensory Physiology.  
Muscles physiology (8 hours) Control of Body Movement  
Cardiovascular Physiology (10 hours) Blood Flow and the Control of Blood Pressure and functional properties of Blood  
Respiratory Physiology (8 hours) Mechanics of Breathing. Gas Exchange and Transport  
The Kidneys (8 hours) Fluid and Electrolyte Balance  
Digestion (8 hours) Energy Balance and Metabolism.  
Endocrine Control of Growth and Metabolism (8 hours)  
Reproduction and Development (8 hours)

**Examination**  
Written.

**More information**  
**IMMUNOLOGICAL BIOTECHNOLOGY**

Second-cycle degree in Industrial Biotechnology  
Language: English  
Teaching period: first semester  
Lecturer: Emanuele Papini / Regina Tavano  
Credits: 8 CFU/ECTS

**Prerequisites**  
The student must have a good preparation in general Immunology.

**Programme**  
Aim: understanding vaccinology in its basic medical terms, having a view on the microbiological, molecular biology and chemical approach to design vaccine nowadays. To understand adjuvancy: empirically and rational design and its connections with nanomedicine. Content of the course: Classic Vaccinology; Main problems in the development of a vaccine; production of recombinant vaccines; Microbial, animal and vegetal models for vaccine production - Reverse Vaccinology: genome based antigen individuation (in silico). Production, quality control; Main vaccines in the paediatric prevention in Italy; Adjuvants - Mucosal adjuvant- micro-nanosized new generation adjuvants. The use of dendritic cells in therapy: perspectives.  
Practical part: Evaluation in vitro of adjuvancy in human dendritic cells. Isolation of monocytes from blood, their differentiation into Dendritic Cells (DCs). Stimulation of DCs with various adjuvants and analysis of cell activation by Elisa (TNF) and flow cytometry (CD86, CD11), RT-PCR (TNF gene transcription). Autologous/heterologous T lymphocytes proliferation and characterization of their immunological competence by FACS in vaccine design.

**Examination**  
Oral.

**More information**  

**INORGANIC CHEMISTRY FOR ADVANCED TECHNOLOGY**

First-cycle degree in Chemistry  
Language: English  
Teaching period: Second Semester  
Lecturer: Vito Di Noto  
Credits: 6 CFU/ECTS

**Prerequisites**  
Mathematics, Physics, Principles of Chimical and Inorganic Chemistry.

**Programme**  
Part 1: Statistical Methods (6ECTS)  
- Visualization: plots including histograms, box plots, scatterplots, scatterplot matrices, etc.  
- Summary statistics and goodness-of-fit tests. One- and two-sample examples, t and F distributions.  
- Concepts of simulation: simple simulation experiments.  
- Logistic regression and Poisson regression.  
- Introduction to the design of experiments, observational studies and sampling methods.

Part 2: Applied Multivariate Techniques (3ECTS)  
- Dimension reduction  
- Classification  
- Clustering

**Examination**  
Oral.

**More information**  
Prerequisites
Basic knowledge in general algebra.

Programme
General introduction to group theory: actions of groups, solvable and nilpotent groups, finitely presented groups. A short history of the classification of finite simple groups. Topological groups. Profinite groups (characterizations, profinite completion, countable based profinite groups, arithmetical properties, subgroups of finite index in profinite groups, Galois groups of infinite dimensional extension). Probabilistic methods in group theory.

Examination
Oral.

More information

Programme
The main goal of the course is to offer a basic introduction to relativistic quantum field theory, for graduate students with interest in theoretical and experimental high energy particle physics. Langrangian and Hamiltonian description for classical fields will be shortly reviewed, focusing in particular on the relation between symmetry properties of the action and conservation laws.

The quantization for free spin 0, spin 1/2 and spin 1 fields (in the covariant approach) is introduced, through the so called “canonical quantization” procedure.

The case of interacting fields is discussed by the introduction of the scattering matrix formalism. With the aid of Feynman graphs the most relevant QED processes at the lowest order are calculated.

Examination
Oral.

More information
**INTRODUCTION TO RING THEORY**

Second-cycle degree in Mathematics  
Language: English  
Teaching period: first semester  
Lecturer: Alberto Facchini  
Credits: 8 CFU/ECTS

**Prerequisites**
Courses of “Algebra 1” and “Algebra 2”. That is, standard undergraduate Algebra.

**Programme**

**Examination**
Oral.

**More information**

---

**LARGE-SCALE CELL CULTURES AND BIOMOLECULES PRODUCTION**

Second-cycle degree in Industrial Biotechnology  
Language: English  
Teaching period: second semester  
Lecturer: Chiara Rampazzo  
Credits: 8 CFU/ECTS

**Prerequisites**
Students are expected to have knowledge and competence of cellular and molecular biology and of biochemistry to be able to understand the fundamental aspects of mammalian large scale cell culture in upstream and downstream processes.

**Programme**
Overview of the biopharmaceutical industry. Upstream and downstream processes. GMP/GLP regulatory requirements for processing biopharmaceuticals. Lab/pilot scale process to implement full manufacturing scale. Consistency and robustness in a fermentation process. Large scale mammalian cell culture. Cell line engineering techniques and common host cell lines used. Bioreactor operation mode: batch, fed batch, continuous and perfusion culture. Selection of bioreactor type (spinner flask, stirred tank). Attachment systems for cell cultivation in adhesion (plates, roller bottle, and stacked plate system) packed bed bioreactor, microcarriers, fluidized bed bioreactor, hollow fiber and wave bioreactor. Perfusion systems for cell cultivation (hollow fiber, spin filter, acoustic cell separation, alternating tangential flow (ATF) system). Design of cell culture medium without serum and with low content of proteins. Scaffold and matrix in bioreactors. How to calibrate oxygen, pH, nutrients and metabolites, cell density and viability in the bioreactor. Design of large scale cell culture process for mammalian cell culture. How to improve cell viability in a process. Expression of cloned proteins in mammalian cells, e.g. interferon and insulin. Large scale...

**Examination**
Oral.

**More information**

---

**MATERIALS FOR ENERGETICS**

Second-cycle degree in Materials Science
Language: English
Teaching period: second semester
Lecturer: Vito di Noto
Credits: 6 CFU/ECTS

---

**Prerequisites**

**Programme**
The course covers the main families of devices for the electrochemical conversion and storage of energy, including primary and secondary batteries, fuel cells, photovoltaic cells and redox flow batteries. The fundamentals of the electrochemical processes taking place at the electrodes are discussed, with a detailed analysis of the interplay between the thermodynamics, kinetics and electrochemistry of the various phenomena. The main properties of the electrolytes are also studied, with a particular reference to the conductivity and charge transfer mechanism. The materials science of the functional materials is covered in detail, highlighting the main physicochemical features and applicability of the various systems. The course is completed by the discussion of the main families of: (a) fuel cells, including PEMFCs, PAFCs, MCFCs and SOFCs; (b) redox flow batteries, such as conventional and hybrid systems; and (c) photovoltaic cells.

**Examination**
Oral.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/SC1174/2013/000ZZ/1116658
**METAMORPHIC PETROLOGY**

Second-cycle degree in Geology and technical Geology
Language: English
Teaching period: first semester
Lecturer: Bernardo Cesare
Credits: 6 CFU/ECTS

**Prerequisites**
Basic knowledge of petrography, geochemistry and mineralogy.

**Programme**
Focusing on the metapelitic system, and through extensive practice at the microscopic laboratory, the course will provide deep insight into the main aspects of metamorphic petrology, such as: metamorphic classification; equilibrium assemblages; metamorphic facies; chemographies and other graphical representations; metamorphic reactions and equilibria; role of fluids in metamorphism, fluid inclusions; geothermobarometry and phase equilibria calculations; metamorphism of pelites; contact metamorphism; crustal anatexis; microstructures of anatectic rocks; melt inclusions in migmatites and granulites.

**Examination**
Oral.

**More information**

---

**MOLECULAR BIOLOGY OF DEVELOPMENT**

Second-cycle degree in Molecular Biology
Language: English
Teaching period: second semester
Lecturer: Francesco Argenton
Credits: 8 CFU/ECTS

**Prerequisites**
Students should have already acquired a basic knowledge of eukaryotic cell biology, differentiation, histology and developmental biology.

**Programme**
Learning of theoretical and practical skills in the field of molecular embryology with emphasis on signaling pathways involved in induction, patterning, determination and differentiation of animals.
- Molecular mechanisms of cleavage, gastrulation and morphogenesis in animal models, Genetic dissection of early development.
- Molecular gradients controlling axis formation in vertebrates and Drosophila.
- Paradigms of molecular developmental genetics.
- Acquisition of skills in the presentation of scientific results; performance of practical molecular embryology experiences and their written reports. Principles of digital imaging applied to embryology.

**Examination**
The exam will be a combination of different tests such as: 1) slide presentation of an article (Journal Club) graded for clarity, completeness of presentation and ability to raise a discussion 2) report of practical laboratory activity and imaging skills 3) Answer an open question on one issue of the course.

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/SC1175/2008/000ZZ/1109366
MOLECULAR ECOLOGY AND DEMOGRAPHY OF MARINE ORGANISMS
Second-cycle degree in Marine Biology
Language: English
Teaching period: first semester
Lecturer: Lorenzo Zane
Credits: 7 CFU/ECTS

Prerequisites
Basic knowledge of Population Genetics and Ecology.

Programme
The course will emphasize the potential offered by molecular genetic approaches in the study of populations of marine organisms. The topics covered by the course will provide a link between marine population ecology and molecular ecology. The program will first highlight the traits of marine organisms relevant for population dynamics and for the determination of genetic variability and differentiation, and then will focus on the use of molecular markers for identification of individuals, stock, populations and species. Molecular markers will be presented with a practical approach, including class and laboratory activity and literature analysis, with the aim of evidence the experimental approach currently used in molecular ecological studies, the kind of data produced and the available strategies for data analysis.

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/IF0360/2013/000ZZ/1109421

MOLECULAR EVOLUTIONARY GENETICS
Second-cycle degree in Molecular Biology
Language: English
Teaching period: first semester
Lecturer: Antonella Russo
Credits: 6 CFU/ECTS

Prerequisites
The basic knowledge deriving from the subjects of the first year of the Second-cycle degree.

Programme
Evolution of sex-chromosome divergence. The molecular mechanisms for dosage compensation of sex-chromosome associated genes: the classical paradigm and new insights. Evolution and significance of genomic imprinting. (16 h)
Gene dosage imbalance and dosage compensation mechanisms: the gene dosage control in aneuploidy, polyploidy, copy number variation syndromes. Non random retention of gene duplicates after whole genome duplication events in evolution. (6 h)
A global critical discussion on the topics of the course and on main perspectives. (2 h)
Critical reading and critical discussion (16 h)

Examination
Oral.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1175/2008/000ZZ/1100291
MORPHODYNAMICS OF LAGOONS, DELTAS AND ESTUARIES UNDER CLIMATE CHANGE

Second-cycle degree in Geology and technical Geology
Language: English
Teaching period: first semester
Lecturer: Andrea D’Alpaos
Credits: 6 CFU/ECTS

Prerequisites
None.

Programme

Examination
Written and/or oral.

More information

NANOBIO TECHNOLOGY

Second-cycle degree in Industrial Biotechnology
Language: English
Teaching period: first semester
Lecturer: Fabrizio Mancin / Emanuele Papini
Credits: 8 CFU/ECTS

Prerequisites
Basic background in chemistry and organic chemistry acquired in the previous fundamental courses. Basic knowledge about formation and properties of nanoparticles. Previous attendance of the “Nanosystems” course (1 semester) is suggested.

Programme

Examination
Oral.

More information
NANOSYSTEMS
Second-cycle degree in Industrial Biotechnology
Language: English
Teaching period: second semester
Lecturer: Flavio Maran / Tommaso Carofiglio
Credits: 8 CFU/ECTS

Prerequisites
B.Sc. level knowledge of Physical Chemistry and Organic Chemistry.

Programme
The course is organized into two parts. Part A: The goal is to provide the underlying principles to understand i) the forces that determine the formation, dimension, and shape of nanosystems; ii) the physicochemical properties of nanosystems compared to molecules and bulk systems; iii) the fundamental processes mediated by nanosystems; iv) the main methodologies for the characterization of nanosystems. Part B: The goal is to provide the necessary information to understand i) how to prepare different types of nanosystems (possible synthetic problems, stability issues and related limits of use) using top-down and bottom-up approaches; ii) how these systems behave, on a molecular level, toward recognition of and binding with other species; iii) how to utilize them in the interaction with biological targets.

Examination
Written + oral.

More information

NUMBER THEORY 1
Second-cycle degree in Mathematics
Language: English
Teaching period: first semester
Lecturer: Francesco Baldassarri
Credits: 8 CFU/ECTS

Prerequisites
A standard Basic Algebra course; a short course in Galois Theory; Linear Algebra; Notions of Calculus.

Programme

Examination
3 written partials + final oral.

More information
**NUMBER THEORY 2**

Second-cycle degree in Mathematics  
Language: English  
Teaching period: second semester  
Lecturer: tbd  
Credits: 6 CFU/ECTS

**Prerequisites**  
Basic notions of algebraic number theory and Galois theory.

**Programme**  
Ramification theory of finite Galois extensions of local fields and p-adic representations of the Galois group (references to J.-P. Serre, Corps Locaux/Local Fields).

**Examination**  
Written.

**More information**  

---

**NUMERICAL MODELING IN GEOSCIENCES**

Second-cycle degree in Geology and technical Geology  
Language: English  
Teaching period: first semester  
Lecturer: Manuele Faccenda  
Credits: 6 CFU/ECTS

**Prerequisites**  
Basic knowledge of some courses of the first semester (Sedimentology, Applied geophysics, Micropaleontology, Applied geochemistry).

**Programme**  
The aim of the course is to make the students deeply understand 1) the physics behind the 3 fundamental equations (conservation of mass, momentum and energy) that describe most of the geological processes, and 2) how to solve them numerically. The numerical strategy used is a mixed Eulerian-Lagrangian method, i.e., finite difference with marker-in-cell technique. In order to close the system of equations to be solved, the petro-physical behavior of rocks will be discussed as a function of their composition and different deformational, pressure, temperature conditions. Through the course, the students will step by step build his thermo-mechanical code that will be tested with a series of benchmarks.

**Examination**  
Oral, together with presentation and discussion of the numerical code.

**More information**  
OPTICS OF MATERIALS

Second-cycle degree in Materials Science
Language: English
Teaching period: first semester
Lecturer: Moreno Meneghetti
Credits: 6 CFU/ECTS

Prerequisites
Basic knowledge of electromagnetic wave propagation and of quantum mechanics.

Programme
Interaction of electromagnetic fields with matter will be described for low and high intensity fields, like those of pulsed lasers, and therefore for the description of linear (absorption and refraction) and non linear (from second order to higher orders effects) properties of matter. Simple models and quantum mechanical approaches will be used for obtaining the optical responses of materials and for obtaining the description of phenomena like Sum Frequency Generation, Difference Frequency Generation, for second order effects, or other third order and higher order effects, like Two Photon Absorption, and dynamics of excited state absorptions. Attention will also be given to the properties of nanostructured materials, like plasmonic properties which induce very interesting effects like SERRS (surface enhanced resonance Raman scattering).

Examination
Oral.

More information

ORGANIC FUNCTIONAL MATERIALS

Second-cycle degree in Materials Science
Language: English
Teaching period: first semester
Lecturer: Michele Maggini
Credits: 6 CFU/ECTS

Prerequisites
Base Chemistry courses of the 3-years Laurea DegreeConcept of allotrope; reactivity of standard and strained olefins and acetylenes; reactivity of the carboxylic group (acyl halides, esters, amides, nitriles); nucleophilic additions to the unsaturated carbon (addition of organolithium and organomagnesium compounds; aldol reactions, cycloadditions (Diels-Alder, 1,3-dipolar cycloadditions to form pyrrolidines, aziridines, ciclopropanes). Semi-empirical methods for the determination of the minimum energy state of an organic molecular structure, calculation and display of frontier orbitals of organic molecules. Excited states of organic molecules: excited singlet state, triplet excited state, intersystem crossing, singlet oxygen vs molecular oxygen. Fundamentals of absorption spectroscopy, emission, IR, Raman, 1H-and 13C-NMR, mass spectrometry, X-ray diffraction analysis; fundamentals of calorimetry (thermogravimetry). Basic Concepts of inorganic semiconductor physics, operation of a conventional solar cell. I/V characteristics, quantum efficiency of a photovoltaic device, photovoltaic conversion efficiency, open circuit voltage, short-circuit current. Basic concepts of electrochemistry (anode, cathode, reduction, oxidation, architecture of an electrochemical cell). Energy and electron transfer in organic molecules. Concept of band-gap for organic and inorganic semiconductors; direct and indirect methods (optical, electrochemical) for the determination of the band-gap. Principles of operation of LED, OLED, FET, OFET. Main polymerization reactions.
Programme: Carbon nanostructures•Fullerenes functionalization• Functionalization of carbon nanotubes and graphene•Semiconducting polymers•Synthesis of semiconducting homo and copolymers •Bandgap engineering of semiconducting polymers•Molecular structures for OLED emitting white or blue light•polymer solar cell

Examination
Oral.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1174/2013/000ZZ/1116657

PATHOLOGY AND HISTOPATHOLOGY

Second-cycle degree in Sanitary Biology
Language: English
Teaching period: second semester
Lecturer: Cesare Montecucco
Credits: 9 CFU/ECTS

Programme
The course consists in 56 hours of lectures that will describe the major causes of diseases, including physical agents, chemicals, drugs, toxins, viruses, bacteria and fungi. The mechanism of pathogenesis of the diseases they cause in humans will be discussed as well as diseases due to alteration of the immune responses.
The course then will treat briefly the mechanism of defense and the reaction of regeneration and repair. The major diseases of blood circulation from heart failure and ischemia to atherosclerosis will be then described. This will be followed by the major human neuro-degeneration diseases. The last part of the course will deal with the molecular, cellular, histological, genetics, clinical pathogenesis of cancers.
The course is integrated by 32 hours of laboratory with experiences on immunological reactions and histopathology of tissue degeneration, atherosclerosis, inflammation and cancers.

Examination
It will be performed with a written test based on three major questions and integrated by an oral part which builds up on the written part.

More information
PERSONAL FINANCE

Second-cycle degree in Statistical Science
Language: English
Teaching period: first semester
Lecturer: Guglielmo Weber
Credits: 9 CFU/ECTS

Prerequisites
Students should have taken a standard finance course, such as Teoria della Finanza (from the graduate programme in “Scienze Statistiche”).

Programme
Personal finance (also known as household finance) asks how households actually invest, and how they should invest. It tackles the issues of participation in financial markets and of portfolio diversification. It further investigates financial investment issues that are particularly relevant for individuals or households: housing and mortgage decisions, consumer credit, and investment in private pensions. The first half of the course will be devoted to the standard model, where individuals maximize expected life-time utility subject to a number of constraints. The second half of the course will instead introduce an alternative approach, known as behavioural finance. Behavioural finance builds upon some descriptive models for decision making under risk recently developed by psychologists, focusing on prospect theory, cumulative prospect theory and on the concepts of loss aversion, probability distortion, and mental accounting. This part of the course will provide a description of market anomalies and inefficiencies, and discuss some psychological biases and limits of real investors that might generate those anomalies. It will then present behavioural models for portfolio selection that can explain these anomalies, also discussing how they can be integrated into the advisory process of banks.

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SS1736/2014/000ZZ/1111479

PETROLEUM GEOLOGY

Second-cycle degree in Geology and technical Geology
Language: English
Teaching period: second semester
Lecturer: Massimiliano Zattin
Credits: 6 CFU/ECTS

Prerequisites
Basic knowledge of some courses of the first semester (Sedimentology, Applied geophysics, Micropaleontology, Applied geochemistry).

Programme
The course will deliver the fundamentals of petroleum geoscience, from the origin and distribution and properties of petroleum to petroleum-bearing rocks. Course topics will be illustrated through case histories and include: the chemistry of petroleum, the organic matter and its maturation in source rocks, petroleum migration, the seal, geology of reservoirs and trap classification. The course will therefore provide the essential tools for understanding the concepts of petroleum system and petroleum play. Case histories will be used to support the concepts and methods, with special emphasis placed upon problems presented by exploration and including some hints about petroleum economics.

Examination
Written.

More information
PHYSICAL CHEMISTRY 4

Second-cycle degree in Chemistry
Language: English
Teaching period: first semester
Lecturer: Flavio Maran / Alberta Ferrarini
Credits: 10 CFU/ECTS

Prerequisites
B.Sc. level knowledge of Physical Chemistry and Physics.

Programme
Chemical kinetics in terms of simple and complex reaction schemes, and current theories. Marcus and nonadiabatic electron-transfer theories. Electrochemical kinetics. The students are then involved in real kinetic experiments. Fundamentals and application of statistical thermodynamics. Electric properties of molecules in connection with the dielectric properties of matter. Molecular interactions, in terms of pair interactions and their expressions as a function of molecular quantities, with application to ionic crystals and fluids. Interaction of molecules with electromagnetic fields.

Examination
Written + oral.

More Information
http://en.didattica.unipd.it/offerta/2014/SC/SC1169/2013/000ZZ/1116188

PHYSICAL METHODS IN ORGANIC CHEMISTRY

Second-cycle degree in Chemistry
Language: English
Teaching period: first semester
Lecturer: Alessandro Bagno
Credits: 6 CFU/ECTS

Prerequisites
Good understanding of organic chemistry and basic concepts of NMR spectroscopy and mass spectrometry.

Programme
Study aims: identification of organic molecules through the analysis of NMR and mass spectra. Contents: Pulsed NMR (instrumentation, chemical shift, relaxation, scalar coupling, effects of molecular symmetry, decoupling). Dynamic NMR. C-13 NMR. Nuclear Overhauser effect. Introduction to correlation spectroscopy. Mass spectrometry. Instrumentation: ion sources and ionization processes (EI, CI, ESI, APCI, APPI, MALDI); mass analyzers (quadrupole, linear and tridimensional ion trap, time-of-flight analyzer, magnetic and electromagnetic analyzers, hybrid instruments); detectors. Tandem mass spectrometry (MSn), collision induced dissociation (CID). Hyphenated methods (GC/MS, LC/MSn). Applications.

Examination
Written.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1169/2013/000ZZ/1098837
PHYSICAL METHODS IN ORGANIC CHEMISTRY
Second-cycle degree in Industrial Chemistry
Language: English
Teaching period: first semester
Lecturer: Alessandro Bagno
Credits: 6 CFU/ECTS

Prerequisites
Good understanding of organic chemistry and basic concepts of NMR spectroscopy and mass spectrometry.

Programme
Study aims: identification of organic molecules through the analysis of NMR and mass spectra. Contents: Pulsed NMR (instrumentation, chemical shift, relaxation, scalar coupling, effects of molecular symmetry, decoupling). Dynamic NMR. C-13 NMR. Nuclear Overhauser effect. Introduction to correlation spectroscopy. Mass spectrometry. Instrumentation: ion sources and ionization processes (EI, CI, ESI, APCI, APPI, MALDI); mass analyzers (quadrupole, linear and tridimensional ion trap, time-of-flight analyzer, magnetic and electromagnetic analyzers, hybrid instruments); detectors. Tandem mass spectrometry (MSn), collision induced dissociation (CID). Hyphenated methods (GC/MS, LC/MSn). Applications.

Examination
Written.

More information

REPRESENTATION THEORY OF GROUPS
Second-cycle degree in Mathematics
Language: English
Teaching period: second semester
Lecturer: Giovanna Carnovale
Credits: 6 CFU/ECTS

Prerequisites
Basic notions of linear algebra (such as diagonalization of matrices) and of group theory (fundamental theorem of homomorphism).

Programme
Representations of groups, algebras, representations of algebras, subrepresentations, morphisms, direct sums. Irreducible representations, indecomposable representations, completely reducible representations. Tensor products, exterior and symmetric powers, duals, representation structure on Hom spaces. Schur’s lemma
Characters and their main properties. First orthogonality relation. Characters are an orthonormal system. Invariance of multiplicities. Dimension of the space of central functions. Decomposition of the regular representation.
Complex irreducible characters are an orthonormal basis for the space of central functions. Second orthogonality relation for characters. Orthogonality of matrix coefficients.
Construction of irreducible representations for abelian groups. How to enumerate complex 1-dimensional representations in a finite group. The character table of the dihedral groups (n even). Induced representations and their character Explicit computation of induced characters. Frobenius reciprocity.
Algebraic integers. More on the dimension of an irreducible representation Frobenius–Schur indicator. Enumerating involutions in a finite group. Compact groups and their representation theory; complex linear algebraic groups. Tangent vectors to an algebraic variety. Tangent bundle and tangent spaces. Linear

RINGS AND MODULES

Second-cycle degree in Mathematics
Language: English
Teaching period: second semester
Lecturer: Riccardo Colpi
Credits: 6 CFU/ECTS

Prerequisites
Notions from the Algebra courses of the first two years of the degree in Mathematics and basic notions on module theory over arbitrary rings.

Programme

Examination
Written exam with a discussion on the compositio

More information
SEDIMENTOLOGY
Second-cycle degree in Geology and technical Geology
Language: English
Teaching period: second semester
Lecturer: Massimiliano Ghinassi
Credits: 6 CFU/ECTS

Prerequisites
Basic knowledge concerning sedimentology (textural features of the main types of sediments and sedimentary rocks) and stratigraphy (temporal and spatial variability of depositional systems).

Programme
1-Introduction to sedimentology (definition of facies and facies association, textural features of sediments, stratal geometries); 2- Processes of sediment transport and deposition (tractional transport by unidirectional and oscillatory currents; mass transport); 3- Post depositional modifications and soft-sediment deformations; 4- Continental depositional environments (alluvial, lacustrine and eolian); 5- Cosastal depositional environments (wave-dominated coasts, deltas, tidal flats); 6- Deep marine depositional environments (turbiditic and contouritic systems); 7- Sequence Stratigraphy (base level, systems tracts, key surfaces, incised valleys, non-marine sequence stratigraphy).

Examination
Written.

More information

STATIC ANALYSIS AND SOFTWARE VERIFICATION
Second-cycle degree in Computer Science
Language: English
Teaching period: first semester
Lecturer: Francesco Ranzato
Credits: 8 CFU/ECTS

Prerequisites
Basic knowledge of programming languages. Formally prerequisite courses are not required.

Programme
Operational program semantics. Denotational program semantics. Static program analysis by abstract interpretation. Dataflow program analysis. Software verification by model checking.

Examination
Oral.

More information
STATISTICAL METHODS FOR PROGRAMME EVALUATION
Second-cycle degree in Statistical Sciences
Language: English
Teaching period: first semester
Lecturer: Giorgio Brunello, Enrico Rettore
Credits: 8 CFU/ECTS

Prerequisites
This course consists of two parts:
part A presents the econometric tools required for the evaluation of public policies.
Part B presents several applications, with special reference to the areas of education and health.

Programme
Definition of causal effects
Evaluation of causal effects in an experimental setting
Evaluation of causal effects in an observational setting
Selection and design
Regression analysis and matching techniques
Instrumental Variables
Difference in difference methods
regression discontinuity
applications of these techniques in the area of education and health will be provided in the second part of the course

Examination
Written.

More information

STATISTICAL MODELS
Second-cycle degree in Statistical Sciences
Language: English
Teaching period: second semester
Lecturer: Luisa Bisaglia, Carlo Gaetan, Nicola Torelli
Credits: 9 CFU/ECTS

Prerequisites
First year courses of the Laurea Magistrale degree in Statistical Sciences, especially Probability Theory, Statistics (advanced).

Programme
Generalized linear mixed models (3ECTS) SECS-S/01
- Introduction to the course: basic ideas
- Generalized linear models: structure and inference
- Binary, multinomial and count data: some important applications
- Overdispersion in GLMs
- Introduction to hierarchical models and to GLMMs
- Likelihood inference in GLMMs Bayesian Hierarchical Models
- Introduction to (generalized) additive mixed models
- Practical sessions with R and R-Bugs
Nonparametric Smoothing Techniques (3ECTS) SECS-S/01
- Density estimation
- Introduction of various smoothers
- Kernel regression
- Splines
- Parameter smoothing choice Multivariate extensions
- Computer labs
Time Series Analysis (3ECTS) SECS-S/03
- Introduction. Linear time series models.
- Linear time series models: model specification.
- Linear time series models: parameter estimation and forecasting.
- Linear time series models: extensions and applications
research developments.
- Nonlinear models: an introduction
- Nonlinear models: Markov-Switching Models and Threshold Autoregression Models

**Examination**
Written

**More information**
http://en.didattica.unipd.it/offerta/2014/SC/SS1736/2014/000ZZ/1111773

---

**STELLAR POPULATIONS**

Second-cycle degree in Astronomy
Language: English
Teaching period: second semester
Lecturer: Gianpaolo Piotto
Credits: 6 CFU/ECTS

**Programme**
The color magnitude diagrams: transformations luminosity-magnitude and temperature-color index. Effects of the interstellar reddening on the color-magnitude diagrams.
The concept of stellar populations: historical background.
Globular Clusters stellar populations
The helium content of the population II stars.
The Galactic model by Eggen, Lynden-Bell and Sandage.
The galactic halo model from Searle and Zinn.
The interstellar medium near to the Sun and the local bubble.
The population I and the galactic disk. Open clusters and field population.
Dwarf Galaxies.
The mass function.
Integrated properties of the stellar populations.
Star formation History in galaxies
Basic principles of the chemical evolution of the stellar populations.
The supernovae: classification, evolution, progenitors.
The use of the supernovae as indicator distances.

**Examination**
Oral.

**More information**
STRATIGRAPHY

Second-cycle degree in Geology and technical Geology
Language: English
Teaching period: second semester
Lecturer: Nereo Preto
Credits: 6 CFU/ECTS

Prerequisites
Knowledges of sedimentary geology and clastic sedimentology; base knowledges of chemistry.

Programme
The aim of this course (or unit) is to make the student familiar with the sedimentary processes, depositional geometries, stratigraphy and diagenesis of carbonate systems. Besides, the student will be introduced to some specific methods of carbonate rock analysis, namely the study of carbonate microfacies and the stable isotope geochemistry (oxygen and carbon) of sedimentary carbonates. Programme: elements of physical oceanography and the inorganic carbon cycle; modes and products of carbonate precipitation in seawater; carbonate factories and carbonate platforms; depositional architecture and stratigraphy of carbonate systems; diagenesis of sedimentary carbonates and dolomitization; microfacies analysis of carbonate rocks; stable isotopic geochemistry of sedimentary carbonates and its application to the reconstruction of diagenetic histories.

Examination
Written.

More information

SUPERCONDUCTING MATERIALS

Second-cycle degree in Materials Science
Language: English
Teaching period: second semester
Lecturer: Vincenzo Palmieri
Credits: 6 CFU/ECTS

Prerequisites
Solid State Physics

Programme
The course will start from the treatment of normal metal conduction both in d.c. regime and in radiofrequency regime and from that will immediately focus on the zero-resistance and on the diamagnetic behavior of superconductors. The two fluid model of a superconductor will be studied in detail and from that we will phenomenologically arrive to the need of Bose condensation and BCS theory. In the end of the course some applications of superconducting materials will be reviewed with special attention to the market of superconducting materials for particle accelerators.

Examination
Oral.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SC1174/2013/000ZZ/1116659
### SYMPLECTIC MECHANICS

Second-cycle degree in Mathematics  
Language: English  
Teaching period: first semester  
Lecturer: Franco Cardin  
Credits: 6 CFU/ECTS

**Prerequisites**  
Elementary Calculus and Geometry

**Programme**  
Riemannian manifolds: Existence of metrics, Whitney theorem.  
Local and global parameterization of the Lagrangian submanifolds and their generating functions. Theorem of Maslov-Hoermander.  
Hamilton-Jacobi equation, its geometrical solutions and links to the Calculus of Variations.  
Conjugate points theory in calculus of variations.  
Relative cohomology and Lusternik-Schnirelman theory. Introduction to Symplectic Topology: existence and classification of critical points of functions and applications to generating functions of Lagrangian submanifolds.  
The min-max solution of Hamilton-Jacobi equation. Morse theory.

**Examination**  
Written.

**More Information**  

---

### THEORETICAL CHEMISTRY

Second-cycle degree in Chemistry  
Language: English  
Teaching period: second semester  
Lecturer: Antonino Polimeno  
Credits: 6 CFU/ECTS

**Prerequisites**  
Basic knowledge in chemistry, physics and mathematics

**Programme**  
The course introduces the basic theoretical skills for the comprehension of molecular processes in condensed phases, and for the interpretation of spectroscopic measurements. Methods will be exemplified in some cases using computer simulations. Classic (non-relativistic) mechanics methods for chemical systems, including molecular dynamics methods for the study of roto-translational motion in condensed phases. Quantum non-relativistic methods in chemistry, including angular momenta, group theory, Hartree-Fock, DFT, multiconfigurational approaches to electronic structures in molecules, linear response theory, stochastic approaches to molecular motions.

**Examination**  
Oral and (optional) written paper on a chosen subject.

**More Information**  
http://en.didattica.unipd.it/offerta/2014/SC/SC1169/2013/000ZZ/1116200
THEORY AND METHODS OF INFECTION
Second-cycle degree in Statistical Sciences
Language: English
Teaching period: second semester
Lecturer: Alessandra Salvan / Nicola Sartori / Laura Ventura
Credits: 9 CFU/ECTS

Prerequisites
First year courses of the Laurea Magistrale degree in Statistical Sciences, especially Probability Theory, Statistics (advanced).

Programme
• Statistical models: approaches to inference, model specification, distribution problems, asymptotic approximations and delta method, simulation.
• Distribution theory: generating functions, moments and cumulants, moment approximations, variance stabilizing and skewness reducing transformations.
• Likelihood, observed and expected quantities: likelihood and sufficiency, invariance and exact sampling properties.
• Likelihood inference and first order asymptotics, nuisance parameters, non-regular models.
• Likelihood, computational aspects in R: Wald and deviance confidence intervals and regions, profile likelihood, simulation, numerical optimization methods.
• Introduction to Bayesian inference: prior information, posterior distribution, choice of the prior distribution, estimation, hypothesis testing and the Bayes factor.
• Estimating equations and pseudolikelihoods: misspecification, estimating equations, quasi likelihood, composite likelihood, empirical likelihood.
• Data and model reductions: sufficiency and completeness, ancillary statistics and conditioning, pseudo-likelihoods, marginal and conditional likelihood.
• The frequency-decision paradigm: statistical decision problems, efficient estimators, optimal tests and confidence regions, conditional inference and similarity.
• Exponential families: natural exponential families, mean value mapping and variance function, marginal and conditional distributions, sufficiency and completeness, likelihood quantities, conditional likelihood, profile likelihood and mixed parameterization, procedures with finite sample optimality properties, first-order asymptotic theory.
• Exponential dispersion families and generalized linear models.
• Group families: groups of transformations, orbits and maximal invariants, conditional and marginal inference.

Examination
1/3 homework. 1/3 final written exam, 1/3 paper and oral presentation reviewing one or two recent research papers.

More information
http://en.didattica.unipd.it/offerta/2014/SC/SS1736/2014/000ZZ/1111802
## Theory of Fundamental Interactions

**Second-cycle degree in Physics**  
Language: English  
Teaching period: second semester  
Lecturer: Andrea Wulzer  
Credits: 6 CFU/ECTS

**Programme**  
The course aims to provide a first introduction to the Standard Model of Electroweak and Strong interactions, discussing its theoretical foundations and the main experimental confirmations of its validity. An elementary knowledge of relativistic Quantum Field Theory and of the use of Feynman diagrams is required. Topics covered include: non-Abelian gauge theories; spontaneous breaking of global and local symmetries; formulation of the Standard Model theory; effective field theories and the Fermi theory of weak interactions; muon decay and neutral current scattering; physics at the Z pole (LEP); VCKM matrix and CP violation; unbroken symmetries in Quantum Field Theory; the QCD Lagrangian and its symmetries; semileptonic matrix elements and meson decays; the system of neutral Kaons, CP violation and GIM mechanism; asymptotic freedom and parton model; neutrino masses and oscillations; the Standard Model as an effective field theory and the Hierarchy Problem.

**Examination**  
Oral.

**More information**  

## Wireless Networks

**Second-cycle degree in Computer Science**  
Language: English  
Teaching period: first semester  
Lecturer: Claudio Enrico Palazzi  
Credits: 6 CFU/ECTS

**Prerequisites**  
Computer Networks

**Programme**  
This class offers an overview of issues related to systems and services on wireless networks. Main problems and protocol solutions available for wireless environments are analyzed, including possible alternatives regarding the state-of-the-art in wireless communication. Through the analysis of services that can be offered over wireless technology, the student will become aware of the future possible evolution and utilization of wireless systems.

**Examination**  
Oral.

**More information**  