

COURSES TAUGHT IN ENGLISH

SCIENCE

DISCIPLINARY AREAS:

 ECONOMICS

 EDUCATION

 LAW

 MEDICINE

 PSYCHOLOGY

 SCIENCE

 SOCIOLOGY

WHY BICOCCA

Bicocca is a young university that will connect you with students from all over the world. You will not just be a student here. You will be a member of the global community.

Since its foundation, the University of Milano-Bicocca has reached beyond its borders entering into various agreements with European and non-European universities.

Research is always global. Our teachers are members of international research groups that share numerous projects and initiatives, with a common commitment to increase the quality of teaching. Our focus on innovation offers students competitive and practical training.



STUDY SCIENCE @MILANO-BICOCCA

The field of Science at the University of Milano-Bicocca comprises of 6 leading departments that offer a diverse portfolio of teaching and research in physics, mathematics, biosciences, computer science, material science and environmental science.

- * Dipartimento Di Biotecnologie E Bioscienze
- * Dipartimento Di Fisica "Giuseppe Occhialini"
- * Dipartimento Di Informatica, Sistemistica E Comunicazione
- * Dipartimento Di Matematica E Applicazioni
- * Dipartimento Di Scienza Dei Materiali
- * Dipartimento Di Scienze Dell'ambiente E Della Terra

The departments bring together the following degree programs:

B 11 Bachelor degrees of which **1 completely taught in English** in cooperation with University of Pavia and Università di Milano-Statale

M 12 Master degrees of which **3 completely taught in English**

OUR INTERNATIONAL OFFER

In the field of Science, our University offers the following degree programs in English:

ARTIFICIAL INTELLIGENCE

ASTROPHYSICS AND SPACE PHYSICS

MARINE SCIENCES

MATERIALS SCIENCE

There are a total of 132 individual courses taught entirely in English across different Degree Programs.

OUR LOCATION

All courses in the field of Science are held at our Milan campus.

TABLE OF CONTENTS:

ARTIFICIAL INTELLIGENCE

- * COGNITIVE PSYCHOLOGY
- * EXPERIMENTAL PHYSICS FOR AI
- * KNOWLEDGE REPRESENTATION AND REASONING
- * THEORETICAL AND COMPUTATIONAL LINEAR ALGEBRA

ASTROPHYSICS AND SPACE PHYSICS

- * COSMIC RAYS
- * GRAVITATIONAL WAVE ASTROPHYSICS
- * QUANTUM FIELD THEORY I
- * RELATIVISTIC ASTROPHYSICS
- * STELLAR ASTROPHYSICS

BIOLOGY

- * ANALYSIS AND MANAGEMENT OF BIODIVERSITY
- * GENETIC MECHANISMS OF HUMAN DISEASE

CHEMICAL SCIENCES AND TECHNOLOGIES

- * CHEMISTRY OF INORGANIC MATERIALS
- * CHEMISTRY OF MOLECULAR MATERIALS
- * LOW ENVIRONMENTAL PROCESSES
- * SOLID STATE AND SURFACE PHYSICAL CHEMISTRY
- * SYNTHESIS AND SPECIAL ORGANIC TECHNIQUES IN MATERIAL CHEMISTRY
- * THERMODYNAMICS AND KINETICS OF MATERIALS
- * THERMODYNAMICS AND KINETICS OF MATERIALS

COMPUTER SCIENCE

- * ADVANCED MACHINE LEARNING
- * ARTIFICIAL INTELLIGENCE

- * CLOUD COMPUTING
- * DATA AND COMPUTATIONAL BIOLOGY
- * EVOLUTION OF SOFTWARE SYSTEMS AND REVERSE ENGINEERING
- * INFORMATION RETRIEVAL
- * UBIQUITOUS, PERSASIVE & CONTEXT-AWARE COMPUTING

DATA SCIENCE

- * CYBERSECURITY FOR DATA SCIENCE
- * DATA SEMANTICS
- * MACHINE LEARNING (module)
- * MACHINE LEARNING AND DECISION MODELS
- * SOCIAL MEDIA ANALYTICS
- * STREAMING DATA MANAGEMENT AND TIME SERIES ANALYSIS
- * TECHNOLOGICAL INFRASTRUCTURES FOR DATA SCIENCE
- * TEXT MINING AND SEARCH

GEOLOGICAL SCIENCES AND TECHNOLOGIES

- * 3D GEOMODELLING
- * ACTIVE TECTONICS AND VOLCANO-TECTONICS
- * ADVANCED METHODS IN STRUCTURAL GEOLOGY
- * APPLIED SEISMOLOGY
- * ASSESSMENT OF GEOLOGICAL RISKS
- * BIOFACIES
- * CLIMATE CHANGE IMPACT ON GEOHAZARDS
- * COASTAL RISK AND DYNAMICS
- * EARTH OBSERVATION FOR GEOLOGY
- * EARTH SYSTEM MODELS IN CLIMATE CHANGE SCIENCE
- * ENVIRONMENTAL GEOCHEMISTRY

- * FUNDAMENTALS OF MARINE PHYSICAL GEOGRAPHY
- * GEOBIOLOGY
- * GEOCHRONOLOGY AND ARCHAEOMETRY
- * GEOENERGY
- * GEO-HYDROLOGICAL RISK
- * LABORATORY OF ADVANCED NUMERICAL MODELLING IN EARTH SCIENCES
- * LABORATORY OF MICROZONATION
- * LABORATORY OF MITIGATION—WORK DESIGN
- * PALEOCEANOGRAPHY AND PALEOCLIMATOLOGY
- * PHYSICS OF THE SEA
- * QUANTITATIVE GEORISK ANALYSIS
- * SEDIMENTARY PETROLOGY
- * SLOPE INSTABILITY

MARINE SCIENCES

- * APPLIED GEOMORPHOLOGY AND HABITAT
- * APPLIED MARINE GEOLOGY
- * BIODIVERSITY AND MARINE ECOLOGY
- * BIODIVERSITY (module)
- * BIOFACIES
- * CHEMISTRY OF INORGANIC MATERIALS
- * CHEMISTRY OF MARINE ENVIRONMENT
- * COASTAL AND MARINE BOTANY
- * COASTAL AND MARINE HAZARD AND RESILIENCE
- * COASTAL AND MARITIME TOURISM
- * COASTAL RISK AND DYNAMICS
- * COMMUNICATION SKILLS AND INTERPERSONAL RELATION MANAGEMENT

- * ENVIRONMENTAL JUSTICE AND GEOPOLITICS OF THE SEA
- * FUNDAMENTALS OF MARINE BIOLOGY
- * FUNDAMENTALS OF MARINE PHYSICAL GEOGRAPHY
- * GEOBIOLOGY
- * HUMAN GEOGRAPHY OF SMALL ISLAND SYSTEMS
- * INTERNATIONAL LAW OF THE SEA AND MARINE ENVIRONMENT PROTECTION
- * MANAGEMENT OF AQUATIC RESOURCES: FISHERIES
- * MARINE ECOLOGY (module)
- * MARINE ENVIRONMENTAL MICROBIOLOGY
- * MARINE INVERTEBRATE ZOOLOGY
- * MARINE MOLECULAR BIOLOGY
- * MARINE VERTEBRATE ZOOLOGY
- * OCEAN MONITORING AND DATA ANALYSIS
- * OCEAN RESOURCES LAW AND POLICY
- * PALEOCEANOGRAPHY AND PALEOCLIMATOLOGY
- * PHYSICS OF THE SEA

MATERIALS SCIENCE

- * APPLIED PHYSICAL CHEMISTRY WITH LABORATORY
- * BASIC CHEMISTRY FOR MATERIALS SCIENCE
- * CHEMISTRY AND TECHNOLOGY OF POLYMERS AND INDUSTRIAL APPLICATIONS
- * CHEMISTRY OF INORGANIC MATERIALS
- * CHEMISTRY OF MOLECULAR MATERIALS
- * ENGINEERED NANOMATERIALS

- * FUNCTIONAL ANALYSIS
- * FUNDAMENTALS OF QUANTUM MECHANICS FOR MATERIALS SCIENTISTS
- * LOW ENVIRONMENTAL IMPACT MATERIALS AND PROCESSES
- * MATERIALS AND DEVICES FOR ENERGY ENGINEERING
- * METALS SCIENCE AND SUSTAINABILITY
- * MOLECULAR ELECTRONICS AND PHOTONICS
- * NANOTECHNOLOGY AND INNOVATION
- * PHYSICAL CHARACTERIZATION OF MATERIALS WITH LABORATORY
- * PHYSICAL CHEMISTRY OF SOLID STATE AND SURFACES
- * PHYSICS AND TECHNOLOGY OF ELECTRONIC DEVICES WITH LABORATORY
- * PHYSICS OF HOMOGENEOUS AND NANOSTRUCTURED DIELECTRICS
- * PHYSICS OF SEMICONDUCTORS
- * RADIATION MATTER INTERACTION
- * SOLID STATE PHYSICS
- * STATISTICAL THERMODYNAMICS OF MATERIALS
- * SURFACE AND INTERFACES
- * SYNTHESIS AND SPECIAL ORGANIC TECHNIQUES IN MATERIAL CHEMISTRY
- * THERMODYNAMICS AND KINETICS OF MATERIALS

MATHEMATICS

- * MATHEMATICAL METHODS IN MODERN PHYSICS
- * REPRESENTATION THEORY

PHYSICS

- * BIOPHOTONICS

- * COMPUTATIONAL STATISTICAL THERMODYNAMICS IN SOLIDS
- * MATHEMATICAL METHODS FOR PHYSICS
- * MC SIMULATION OF RADIATION DETECTORS
- * NUCLEAR AND SUBNUCLEAR MEASUREMENTS LABORATORY
- * NUCLEAR AND SUBNUCLEAR MEASUREMENTS LABORATORY II
- * PLASMA PHYSICS II
- * QUANTUM FIELD THEORY I
- * QUANTUM FIELD THEORY II
- * SEMICONDUCTORS PHYSICS
- * SOLID STATE AND ELECTRONICS LABORATORY II
- * STATISTICAL MECHANICS
- * SURFACE AND INTERFACES
- * THEORY AND PHENOMENOLOGY OF FUNDAMENTAL INTERACTIONS
- * THEORY OF CONDENSED MATTER I

SCIENCE AND TECHNOLOGIES FOR ENVIRONMENT AND LANDSCAPE

- * LOW ENVIRONMENTAL IMPACT PROCESSES

THEORY AND TECHNOLOGY OF COMMUNICATION

- * APPLIED SOCIAL COGNITION TO PUBLIC POLICIES
- * APPLIED SOCIAL COGNITION TO PUBLIC POLICIES
- * CONSUMER PSYCHOLOGY
- * DATA SEMANTICS
- * INFORMATION RETRIEVAL
- * MULTIMEDIA DATA PROCESSING
- * UBIQUITOUS, PERVASIVE & CONTEXT-AWARE COMPUTING

3D GEOMODELLING

LECTURER: BISTACCHI ANDREA LUIGI PAOLO

CONTENTS

3D geomodelling techniques, discussed in a synthesis on theory, and implemented in exercises and case studies with industry-standard software. the course includes a review of theory tightly integrated with practical exercises. Principal topics are:

1. Fundamentals of geomodelling, topology, discrete models, grids, geostatistics and interpolation;
2. 3D data sources: surface geology, borehole, and geophysical data (e.g. 2D and 3D seismic);
3. Software: problems and functionalities;
4. Modelling a simple layer-cake stratigraphy;
5. Fault networks;
6. Cylindrical folds;
7. Complex geo-bodies;
8. Representation, modelling and simulation of properties of geological objects;
9. Fracture network modelling;
10. Retrodeformation;
11. Using 3D geomodels as input data for further modelling steps: mechanical models, flow simulators in hydrocarbon geology, hydrogeological models, etc.

PREREQUISITES

Tectonics and structural geology.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38100>

M

YEAR: 2

SEM: 1

ECTS: 4

DEGREE in Geological Sciences and Technologies

CONTACT: andrea.bistacchi@unimib.it

ACTIVE TECTONICS AND VOLCANOTECTONICS

LECTURER: TIBALDI ALESSANDRO

CONTENTS

The general objectives comprehend the preparation of students in order to carry out geological-structural analyses applied to the recognition of recent and active tectonic deformations. In the second part of the course, students will analyse the structures in volcanic areas in order to distinguish those produced by tectonic forces from those caused by magmatic forces.

PREREQUISITES

Base knowledge of geology, structural geology and geomorphology.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38123>

M

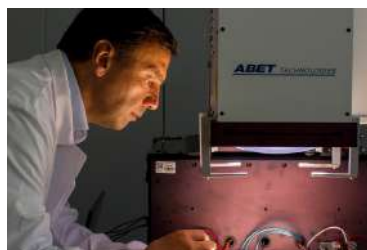
YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Geological Sciences and
Technologies

CONTACT: alessandro.tibaldi@unimib.it



ADVANCED MACHINE LEARNING

LECTURER: BIANCO SIMONE, MESSINA VINCENZINA

CONTENTS

This machine learning advanced course is aimed especially for students who are already familiar with the basics of machine learning and wish to strengthen their knowledge and explore important advanced topics in order to possess in-depth and wide range capabilities at this so important field.

The course will cover some of the most important advanced topics in machine learning such as deep learning and reinforcement learning, with their underlying theory but also a focus on modeling and practical implementation.

These advanced techniques will be applied to a number of applications, including: image recognition, natural language processing, recommendation systems.

PREREQUISITES

Basic Machine Learning techniques.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37951>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Science

CONTACT: enza.messina@unimib.it

PROGRAM CODE: F7401Q096

ADVANCED METHODS IN STRUCTURAL GEOLOGY

LECTURER: BISTACCHI ANDREA LUIGI PAOLO

CONTENTS

The course covers advanced techniques for the collection, analysis and modelling of quantitative structural geology data at different scales in the field and in the lab.

PREREQUISITES

Tectonics and Structural Geology.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38099>

M

YEAR: 2

SEM: 1

ECTS: 4

DEGREE in Geological Sciences and
Technologies

CONTACT: andrea.bistacchi@unimib.it



PROGRAM CODE: F0601Q068

ANALYSIS AND MANAGEMENT OF BIOCOENOSIS

LECTURER: MANGANO MARIA CRISTINA

CONTENTS

N/A

PREREQUISITES

N/A

WEBSITE <https://elearning.unimib.it/course/info.php?id=38876>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Biology

CONTACT: maria.mangano@unimib.it

APPLIED GEOMORPHOLOGY AND HABITAT

LECTURER: BASSO DANIELA MARIA, SAVINI ALESSANDRA, BRACCHI VALENTINA
ALICE

CONTENTS

This course deals with the geomorphological and geobiological characterization of benthic habitats, with an emphasis on marine benthic bioconstructions of the temperate Mediterranean Sea and the shallow water tropical reef environments. It focuses on field and remote observations of characteristic habitats and their multi-scale relationships with the associated abiotic components. Environmental issues, related to the role of habitat mapping and monitoring in marine ecosystem management, are explained and discussed using case histories.

Laboratory activities will offer the students the opportunity to use traditional and new advanced methods and techniques for mapping and modelling the distribution of marine benthic habitats.

PREREQUISITES

Introduction to Marine Physical Geography, Geobiology, Invertebrate zoology (base level) or systematic and general Palaeontology.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38156>

M

YEAR: 1
SEM: 2
ECTS: 6
DEGREE in Marine Sciences
CONTACT: daniela.basso@unimib.it
alessandra.savini@unimib.it



APPLIED MARINE GEOLOGY

LECTURER: FALLATI LUCA, NOMIKOU PARASKEVI

CONTENTS

To provide knowledge on the major geological hazards in marine and coastal environment, which are caused by geological processes that change dramatically the environmental conditions and present severe threats to coastal populations, offshore and onshore properties and offshore built infrastructures.

The course will provide basic knowledge about the use of innovative marine technologies to identify the marine geohazards and inherent risks and our ability to deal with them.

PREREQUISITES

Physics of the Sea; Introduction to Marine Physical Geography; Law of the Sea.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38164>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: luca.fallati@unimib.it
paraskevi.nomikou@unimib.it

APPLIED PHYSICAL CHEMISTRY WITH LABORATORY

LECTURER: FERRARA CHIARA, RUFFO RICCARDO, SANTORO CARLO

CONTENTS

Aims of the lectures (5 CFU) are to supply the student with base knowledge about the physical chemistry of ionic conductors and the electrochemistry and its application in the energy conversion by electrochemical devices and in corrosion and protection of metals. The lab part (3 CFU) is devoted to the characterization of materials and electrodes for secondary batteries and electrochromic applications. In the lab FT-IR, XRPD, electrochemical and spectroelectrochemical techniques will be used.

Ionics and Electrodicts. Batteries and Corrosion. Lab. experience.

PREREQUISITES

Standard physic and mathematic knowledge , thermodynamic and kinetic of chemical system.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37948>

M

YEAR: 1
SEM: 1+2
ECTS: 8
DEGREE in Materials Science
CONTACT: riccardo.ruffo@unimib.it



APPLIED QUANTUM TECHNOLOGIES

LECTURER: NUCCIOTTI ANGELO

CONTENTS

- * qubits practical implementations
- * operate with qubits
- * qubits as sensors
- * superconducting qubits
- * design, fabrication and characterization
- * usage and related technologies
- * application examples
- * other type of qubits and examples of their application

PREREQUISITES

A course in Quantum Mechanics at the bachelor's degree level in physics (the basic concepts required will be recalled)

WEBSITE <https://elearning.unimib.it/course/info.php?id=39133>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: angelo.nucciotti@unimib.it

APPLIED SEISMOLOGY

LECTURER: PACOR FRANCESCA, AUGLIERA PAOLO

CONTENTS

- a) fundamentals of seismology;
- b) introduction to the seismic source;
- c) principles of attenuation of elastic waves and ground motion;
- d) shaking parameters, response spectrum, ground motion prediction equations;
- e) site effects;
- f) fundamentals of seismic hazard;
- g) seismic microzonation;
- h) introduction to the Italian seismic code (sections of interest to geologists).
- i)

PREREQUISITES

None

WEBSITE <https://elearning.unimib.it/course/info.php?id=38128>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: paolo.augliera@unimib.it
francesca.pacor@unimib.it

APPLIED SOCIAL COGNITION TO PUBLIC POLICIES

LECTURER: MARI SILVIA

CONTENTS

The course will provide an overview of domains in which socio-cognitive theories and research have been applied outside the laboratory to influence public policies. The course will be devoted to examining a sample of behavioral domains and contexts in which applied research has made contributions. These include political issues (e.g., promoting participation, reducing inequalities and improving intergroup relations), psychological and physical health (e.g., promotion and prevention behaviors), environmental concerns (e.g., climate change), mass media effects (e.g., scientific misinformation and conspiracy theories). Practical problems and ethical issues unique to the applied research will be considered.

PREREQUISITES

No previous knowledge is required. Good knowledge of the basis of Social Psychology enables more aware fruition of the course contents. Students lacking such basic knowledge are encouraged to ask for a list of basic references.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37771>
<https://elearning.unimib.it/course/info.php?id=38264>

M

YEAR: 2

SEM: 1

ECTS: 8

DEGREE in Theory and Technology of Communication
Applied Experimental Psychological Sciences

CONTACT: silvia.mari@unimib.it

ARTIFICIAL INTELLIGENCE

LECTURER: BANDINI STEFANIA, BIANCHI FEDERICO, PALMONARI MATTEO LUIGI

CONTENTS

The aim of the course is to enable the student to master the knowledge and basic tools necessary to comprehend, use and create Artificial Intelligence systems, together with the ability to analyze classes of problems particularly suitable to be solved with methods and techniques that characterize the discipline. The practical and at the same time explorative nature of Artificial Intelligence will invite the student to learn how to discriminate among problems for which current solutions can be used and innovative directions of research in this field. The students will be given conceptual, computational and basic methodological tools to understand and develop innovative solutions to automation problems through advanced Artificial Intelligence techniques. The course is aimed at students who aspire to enter into work and research environments where innovative choices prevail for the solution of complex problems and areas with a strong multidisciplinary component.

PREREQUISITES

Basic knowledge of logics and mathematics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37949>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Science

CONTACT: stefania.bandini@unimib.it



ASSESSMENT OF GEOLOGICAL RISKS

LECTURER: FRATTINI PAOLO

CONTENTS

The course aim at providing concepts and methodologies for the analysis, the evaluation and the mitigation of geological risks.

Definition of hazard, vulnerability and risk. Description and assessment of flood risk, seismic risk, landslide risk and snow avalanche risk. Introduction on coastal risks and volcanic risk.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38124>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: paolo.frattini@unimib.it

ASTRONOMICAL INSTRUMENTATION

LECTURER: ZANNONI MARIO

CONTENTS

Introduction to the physical principles of operation of telescopes and detectors of electromagnetic, gravitational and particle radiation (cosmic rays).

PREREQUISITES

Physics 1, Physics 2, Physics 3, Structure of Matters

WEBSITE <https://elearning.unimib.it/course/info.php?id=35307>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: mario.zannoni@unimib.it

ASTROPHYSICS OF GRAVITATIONAL WAVES

LECTURER: SESANA ALBERTO

CONTENTS

- 1- theory of gravitational wave emission
- 2- detection methods: interferometers and pulsar timing
- 3- astrophysical sources of gravitational waves and their signals
- 4- the bands of the gravitational wave spectrum and the observers that cover them: LIGO / Virgo, LISA, PTAs
- 5- basics of gravitational wave data analysis

PREREQUISITES

None, besides the basic classes of the bachelor.

It is advised to take this class after Relativistic Astrophysics. Some of the concepts developed during the course will be easier to understand if the students have attended the General Relativity course. I stress, however, that this is not a needed prerequisite, as the course will be largely self-contained.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35306>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: alberto.sesana@unimib.it



ASTROSTATISTICS

LECTURER: GEROSA DAVIDE

CONTENTS

The use of statistics is ubiquitous in astronomy and astrophysics. Modern advances are made possible by the application of increasingly sophisticated tools, often dubbed as "data mining", "machine learning", and "artificial intelligence". This class provides an introduction to (some of) these statistical techniques in a very practical fashion, pairing formal derivations to hands-on computational applications. Although examples will be taken almost exclusively from the realm of astronomy, this class is appropriate to all Physics students interested in machine learning.

PREREQUISITES

No formal prerequisites. Some previous knowledge of the python programming language is highly recommended (see below for some catch-up resources).

WEBSITE <https://elearning.unimib.it/course/info.php?id=35298>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: davide.gerosa@unimib.it

BASIC CHEMISTRY FOR MATERIALS SCIENCE

LECTURER: BEVERINA LUCA, TOSONI SERGIO PAOLO

CONTENTS

Basic course of general, inorganic and organic chemistry.

The general and inorganic chemistry deals with the fundamental aspects of chemistry, with the aim to relate the physical properties of the materials with their chemical composition. The main chemical phenomena (reactions, equilibria, pH), as well as some basis of stoichiometry, will be also addressed.

In organic chemistry the structural aspects, the weak bonds responsible for molecular interactions and the covalent bonds that give rise to polymeric structures of interest for materials sciences will be addressed.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37939>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: luca.beverina@unimib.it
sergio.tosoni@unimib.it

PROGRAM CODE: F7502Q004

BIODIVERSITY AND MARINE ECOLOGY

MODULES: Biodiversity (ref. F7502Q004M)
Marine Ecology (ref. F7502Q005M)

LECTURER: SHAZLA MOHAMED, MONTANO SIMONE, GALLI PAOLO, SEVESO DAVIDE

CONTENTS

Biodiversity: Introduction to Marine Biodiversity; Biodiversity of Plankton, Benthos and Nekton; Spatial and Temporal Patterns of Marine Biodiversity; Global threats and for global Biodiversity and Anthropogenic Impacts; Coral Reef's biodiversity; Marine fisheries and Biodiversity.

Marine Ecology: N/A

PREREQUISITES

See course modules.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38157>

M

YEAR: 1

SEM: 1

ECTS: 12

DEGREE in Marine Sciences

CONTACT: paolo.galli@unimib.it



BIODIVERSITY (module of Biodiversity and Marine Ecology - F7502Q004)

LECTURER: SHAZLA MOHAMED, MONTANO SIMONE

CONTENTS

Introduction to Marine Biodiversity; Biodiversity of Plankton, Benthos and Nekton; Spatial and Temporal Patterns of Marine Biodiversity; Global threats and for global Biodiversity and Anthropogenic Impacts; Coral Reef's biodiversity; Marine fisheries and Biodiversity.

PREREQUISITES

None

WEBSITE <https://elearning.unimib.it/course/info.php?id=38158>

M

YEAR: 1

SEM: 1

ECTS: 6 (Only if the entire course is frequented)

DEGREE in Marine Sciences

CONTACT: simone.montano@unimib.it

PROGRAM CODE: F7502Q014

PROGRAM CODE: F7401Q082

BIOFACIES

LECTURER: BASSO DANIELA MARIA, MALINVERNO ELISA

CONTENTS

Benthic facies and applied marine paleoecology: Identifying biofacies as a tool for paleoenvironmental definition. Applications and examples. Introduction to applied marine paleoecology: rationale, sampling strategies, case histories. Multivariate statistics applied to paleoecological analysis. Observations, laboratory analyses and techniques.

Microfacies; the Pelagic Environment: Recognition of biofacies for the definition of the pelagic paleoenvironment in different oceanographic settings. Bases of plankton taxonomy. Taphonomy. Applications and examples from present-day and past environments.

PREREQUISITES

Paleontology, Geobiology.

<https://elearning.unimib.it/course/info.php?id=38137>

WEBSITE <https://elearning.unimib.it/course/info.php?id=38160>

M

YEAR: 1

SEM: 2

ECTS: 6/8

DEGREE in Marine Sciences
Geological Sciences and
Technologies

CONTACT: daniela.basso@unimib.it



CAUSAL NETWORKS

LECTURER: BREGOLI ALESSANDRO

CONTENTS

Main contents are as follows; the potential outcome framework, main definitions and properties of probabilistic graphical models with specific reference to Bayesian networks, causal networks and structural causal models, randomized experiments, nonparametric identification of causal effect, estimation of causal effect, unobserved confounding, instrumental variables, structural learning from observational data and from observational and intervention data, basic concepts of transfer learning and transportability, and finally a basic introduction to counterfactuals.

PREREQUISITES

Basic knowledge of graph theory, optimization, probability and statistics, programming; mainly R and Python.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37965>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Science

CONTACT: alessandro.bregoli@unimib.it

CHEMISTRY AND TECHNOLOGY OF POLYMERS AND INDUSTRIAL APPLICATIONS

LECTURER: COMOTTI ANGIOLINA , SOZZANI PIERO ERNESTO

CONTENTS

The aim of the course is to highlight the applications of a few classes of polymers, and both up-to-date scientific methods and technological processes to improve their properties.

The course encompasses advanced technological processes in the synthesis and transformation of polymers, including new methods of polymer synthesis, introduction to hybrid materials and nanochemistry with particular emphasis to preparation and characterization of polymer materials endowed with heterogeneous interfaces and new functional properties.

PREREQUISITES

Basic knowledge of macromolecular chemistry.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37931>

M

YEAR: 1
SEM: 2
ECTS: 6
DEGREE in Materials Science
CONTACT: angiolina.comotti@unimib.it
piero.sozzani@unimib.it



PROGRAM CODE: F5302Q018

PROGRAM CODE: F5401Q042

CHEMISTRY OF INORGANIC MATERIALS

LECTURER: MORET MASSIMO

CONTENTS

Synthesis of functional materials (single crystals, polycrystalline powders, films, fibers, amorphous and porous materials): solid-state reactions, synthesis of solids from the gas phase, synthesis of solids from melts and solutions at low and high temperature, sol-gel processes. Fundamentals of nucleation of crystals and growth mechanisms.

PREREQUISITES

Chemistry of inorganic materials requires an interdisciplinary approach exploiting general and inorganic chemistry, organic chemistry, physical chemistry (thermodynamics and chemical equilibria) and basic knowledge of crystallography.

<https://elearning.unimib.it/course/info.php?id=38015>

WEBSITE <https://elearning.unimib.it/course/info.php?id=37934>

M

YEAR: 1/2

SEM: 1

ECTS: 6

DEGREE in Materials Science
Chemical Sciences and Technologies

CONTACT: massimo.moret@unimib.it

CHEMISTRY OF MARINE ENVIRONMENT

LECTURER: FERRERO LUCA

CONTENTS

The course provides an understanding of the chemical composition of seawater and related chemical reactions. Equilibrium and steady state conditions in aqueous solution are discussed. A particular attention is also given to priority and emerging pollutants.

The course aims at providing fundamental knowledges concerning the processes and mechanisms that regulate the chemical composition of the sea and oceans. A special attention is given to climate change impact on the chemistry of the Oceans.

PREREQUISITES

Basics of inorganic and organic chemistry.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38149>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Marine Sciences

CONTACT: luca.ferrero@unimib.it



PROGRAM CODE: F5302Q019 (BLENDED)

PROGRAM CODE: F5401Q051

CHEMISTRY OF MOLECULAR MATERIALS

LECTURER: BEVERINA LUCA

CONTENTS

Molecular materials are rapidly gaining momentum, both in terms of scientific research and technological applications. Aim of the course is to provide a detailed knowledge of the structure properties relationships ruling the behaviour of such materials, with particular emphasis on electronic, optical and optoelectronic properties.

PREREQUISITES

Molecular based materials require an interdisciplinary approach. Elements of Materials science, Organic chemistry, Physical chemistry, Medicinal chemistry, environmental chemistry, physics.... (depending on the application) are required

<https://elearning.unimib.it/course/info.php?id=37938>

WEBSITE <https://elearning.unimib.it/course/info.php?id=38016>

M

YEAR: 1/2

SEM: 2

ECTS: 6

DEGREE in Materials Science
Chemical Sciences and Technologies

CONTACT: luca.beverina@unimib.it

PROGRAM CODE: F7401Q110

CLIMATE CHANGE IMPACTS ON GEOHAZARDS

LECTURER: FRATTINI PAOLO

CONTENTS

N/A

PREREQUISITES

N/A

WEBSITE <https://elearning.unimib.it/course/info.php?id=38131>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Geological Sciences and
Technologies

CONTACT: luca.ferrero@unimib.it



CLOUD COMPUTING

LECTURER: CIAVOTTA MICHELE, DE PAOLI FLAVIO MARIA, TUNDO ALESSANDRO

CONTENTS

The goal of the course is to provide students with fundamental elements to understand and design distributed service-oriented applications. After the course, students will master the most important models for distributed systems based on Cloud technology, and the basic characteristics of languages and tools for their development.

They will be able to analyze and design applications based on microservices and container-based technology..

PREREQUISITES

Thorough comprehension of networking and distributed system principles to design and develop distributed applications.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37956>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Sciences

CONTACT: flavio.depaoli@unimib.it



COASTAL AND MARINE BOTANY

LECTURER: GENTILI RODOLFO FILIPPO

CONTENTS

This subject will focus on algae and plants of both marine submerged and emerged environments and particularly on marine microalgae, macroalgae and seagrasses and on terrestrial plants belonging to coastal vegetation, with a special emphasis on those typical of Mediterranean and tropical regions. In the introductory part of the course attention will be paid in analysing the main evolutionary stages which have led to the actual biodiversity of marine algae and plants and in deepening in the knowledge on the major taxonomic groups of algae and plants that can be found in Mediterranean and tropical marine and coastal environments. The second part of the course, instead, will focus on coastal vegetation of Mediterranean and tropical regions. Initially, a general characterization will be conducted, considering the main taxonomic groups of coastal plants, prior to describe in detail the vegetation of the most particular habitats (cliffs, estuaries, mangrove forests, etc.). The third part of the course will be dedicated to analyse the main environmental and human problems related to marine algae, such as biological invasions and harmful algal blooms. Finally, the last lessons will be organized as workshops, during which small groups of students will be asked to deep in their knowledge on the main uses of marine algae and plants and to share them with their mates.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38145>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: rodolfo.gentili@unimib.it

COASTAL AND MARINE HAZARD AND RESILIENCE

LECTURER: SCHMIDT MULLER DI FRIEDBERG MARCELLA

CONTENTS

The course explores the complexity of the relationship between culture, risk and disaster. The aim is to increase understanding of how best to deal with the risks associated with coastal and marine environments, and to examine human resilience to risk, exploring the cultural dimension of disaster.

Definitions and uses of the terms hazard, risk and disaster, vulnerability and resilience. Hazards, risks and disasters in marine and coastal areas. Culture, knowledge and world views related to hazards. The cultural dimension of disaster risk reduction (DRR). Cultural and political aspects of disasters, catastrophes and natural hazards (tsunamis, floods, climate change): adaptation, mitigation and resilience. Governance, stakeholders, communication and participation.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38142>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: marcella.schmidt@unimib.it



COASTAL AND MARITIME TOURISM

LECTURER: MALATESTA STEFANO, PIANA PIETRO

CONTENTS

This course aims at critically examining tourism activities and industry in coastal regions and marine spaces, focusing on social, economic and cultural impacts of tourism development in these specific contexts. Various types of tourism -such as ecotourism - in coastal and marine locations will be presented and discussed based on a number of selected case studies (e.g: the Mediterranean Sea, Venice, the Black Sea; the Caribbean islands; The Red Sea; The Maldives). Moreover, the course will provide critical insights to explore the relationship between tourism economies and performances, socio-spatial practices and environmental issues, and finally it will explore coastal and marine tourism policies, strategies and guidelines as promoted by EU and other institutional agencies.

PREREQUISITES

N/A.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38143>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: stefano.malatesta@unimib.it

PROGRAM CODE: F7502Q023

PROGRAM CODE: F7401Q118

COASTAL RISKS AND DYNAMICS

LECTURER: D'ALESSANDRO FELICE

CONTENTS

The course is intended to provide basic knowledge of coastal processes for the proper management of the coastline from a physical point of view. The knowledge on maritime hydraulics (wave genesis, wave transformations, coastal currents), sediment transport and beaches morphodynamic will be deepened. Coastal risk elements will be presented, with particular regard to coastal erosion and possible defense approaches. The main techniques for studying and monitoring the coastal system will be examined. The part of the Coastal Risk Course aims to provide the student with advanced knowledge in the study and forecast of the impact of catastrophic events on the coastline. The training obtained can be applied for Civil Protection purposes and to minimize impacts on coastline.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=30860>
<https://elearning.unimib.it/course/info.php?id=38141>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences
Geological Sciences and
Technologies

CONTACT: felice.dalessandro@unimib.it



PROGRAM CODE:

COGNITIVE PSYCHOLOGY

LECTURER: BRICOLO EMANUELA

CONTENTS

PREREQUISITES

WEBSITE <https://elearning.unimib.it/course/info.php?id=38143>

B

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Artificial Intelligence

CONTACT: emanuela.bricolo@unimib.it

COMMUNICATION SKILLS AND INTERPERSONAL RELATION MANAGEMENT

LECTURER: STREPPARAVA MARIAGRAZIA , RUSSO SELENE

CONTENTS

The course will provide the basic knowledge of communication skills (dyadic and group) and a general overview of the most important psychological mechanisms involved in interpersonal relationship; students will learn these basic principles also by practical experiences and exercises (group activities, role-play, case simulation) and will learn some emotions and behaviors regulation strategies.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38144>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: mariagrazia.strepparava@unimib.it

COMPUTATIONAL STATISTICAL THERMODYNAMICS IN SOLIDS

LECTURER: BERGAMASCHINI ROBERTO, MONTALENTI FRANCESCO CIMBRO M.

CONTENTS

The main goal of the Course is to provide to the students some key theoretical/computational tools for approaching at the atomic scale thermodynamics and kinetics of solids.

Summary of basic concepts in classical statistical mechanics, adiabatic approximation, classical approximation for the motion of nuclei, ab initio and classical molecular dynamics, scientific coding with Matlab, implementation in Matlab of a molecular dynamics code, application of the molecular dynamics code, configurational Monte Carlo, implementation of a configurational Monte Carlo code, kinetic Monte Carlo, transition state theory.

PREREQUISITES

Basic classical and quantum mechanics. Knowledge of the Boltzmann distribution.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39134>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: roberto.bergamaschini@unimib.it
francesco.montalenti@unimib.it



CONSUMER PSYCHOLOGY

LECTURER: OLIVERO NADIA

CONTENTS

The course provides a complete overview of the main topics of Consumer Psychology and integrates theoretical contributions with case histories from main brands and companies.

The course is divided in three parts.

- * The first one is about theoretical and scientific models for the understanding of the consumer as an individual, and focuses on decision making, perception, and learning.
- * The second part is concerned with motivation, attitudes, identity construction in relation with products consumption and brands, the role of the socio-cultural context, the social group and advertising.
- * The third part explores fields of application such as 'information communication technologies for consumer research and strategy, food consumption, marketing of experience and non-conventional marketing.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37770>
<https://elearning.unimib.it/course/info.php?id=38242>

M

YEAR: 2

SEM: 2

ECTS: 8

DEGREE in Theory and technology of Communication
Social, Economic and Decision-Making Psychology

CONTACT: nadia.olivero@unimib.it

COSMIC RAYS

LECTURER: GERVASI MASSIMO

CONTENTS

Cosmic rays (CR) will be described in relation to the experimental data, their composition and properties. Main topics will be: origin and astrophysical sources of CR; acceleration processes; interaction with interstellar medium; propagation in the Milky Way; interaction with solar wind; propagation in the solar cavity; interaction with the Earth magnetic field; radiation belts and geomagnetic cut-off; interaction with Earth atmosphere; atmospheric showers; CR in fundamental physics and cosmology.

PREREQUISITES

Knowledge of the previous courses of physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35297>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: massimo.gervasi@unimib.it



COSMIC STRUCTURE FORMATION

LECTURER: CANTALUPO SEBASTIANO

CONTENTS

Content goals/objectives include:

- The students will learn how to investigate and characterise the physical properties of the largest baryonic structures in the universe by studying in detail the mechanisms that produce and modify the electromagnetic radiation detectable with astronomical observing facilities.
- The students will learn that radiation processes are an active agent in shaping the formation and evolution of cosmic structures in the universe from the largest scales associated with intergalactic gas to galaxies.
- The students will learn how to use astronomical observations at different wavelengths to infer physical properties (mass, star formation rate, composition) of galaxies and their constituents (stars, interstellar medium, dark matter).
- The students will learn about the diversity of galaxies in the universe, in terms of, e.g., morphology, kinematics, stellar populations, properties of the interstellar medium. In this context, the students will learn how to identify possible trends and regularities, which may be then used as possible clues to their physical origin.

PREREQUISITES

The course is geared towards students in the physical sciences with no particular prerequisites on previous classes or study background. The only prerequisites necessary for this class are: i) motivation, ii) curiosity, iii) willingness to actively participate.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35292>

M

YEAR: 1
SEM: 1
ECTS: 6
DEGREE in Astrophysics and Space Physics
CONTACT: sebastiano.cantalupo@unimib.it



CYBERSECURITY FOR DATA SCIENCE

LECTURER: DENARO GIOVANNI, FERRETTI CLAUDIO

CONTENTS

The domain of cybersecurity: technologies where we apply the discipline, and goals: basic terminology in the area (e.g. vulnerability VS exploit, etc.); unifying principle: technologies introduce possibilities of the being used improperly. Protection of data: cryptography, filtering network traffic, detection of threats. Improving security without technology: awareness and best practices. Case studies: data management frameworks, and where they can be hardened against security threats.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37905>

M

YEAR: 2
SEM: 1
ECTS: 6
DEGREE in Data Science
CONTACT: giovanni.denaro@unimib.it
claudio.ferretti@unimib.it



DATA AND COMPUTATIONAL BIOLOGY

LECTURER: ANTONIOTTI MARCO

CONTENTS

The course is composed of three main parts/topics.

- Introduction to Biology and Biochemical Network Modeling
- Modeling and Simulation of Biological systems.
- Data Analysis of biomedical phenomena, with special attention to oncological progression phenomena.

PREREQUISITES

Introductory courses (undergraduate or master level) on Mathematics, Probability and Statistics, and/or Biology and Biochemistry. Some knowledge of R, Python (et al.) programming.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37953>

M

YEAR: 2
SEM: 1
ECTS: 6
DEGREE in Computer Science
CONTACT: marco.antoniotti@unimib.it



PROGRAM CODE: F9101Q011

PROGRAM CODE: F9201P208

DATA SEMANTICS

LECTURER: PALMONARI MATTEO LUIGI, VIMERCATI MANUEL

CONTENTS

The course presents computational methods to represent, harmonize and reconstruct the semantics of data used in data science applications, with a particular focus on:

- * models and languages developed within the semantic web to support the integration of heterogeneous data (knowledge graph, data linking, ontologies, RDF, RDFS, OWL);
- * techniques for the integration of data and vocabularies;
- * techniques for extracting information from texts (outline);
- * artificial intelligence models for data and knowledge exploration.

PREREQUISITES

Mathematics and computer science as taught in the compulsory courses of the first semester.

<https://elearning.unimib.it/course/info.php?id=37920>

WEBSITE <https://elearning.unimib.it/course/info.php?id=37785>

M

YEAR: 1/2

SEM: 2

ECTS: 6

DEGREE in Data Science

Theory and Technology of Communication

CONTACT: matteo.palmonari@unimib.it

EARTH OBSERVATION FOR GEOLOGY

LECTURER: ROSSINI MICOL

CONTENTS

Theory and practice for remote sensing data analysis using open-source software for image processing for geological applications. The aim of the course is to provide expertise in the analysis and interpretation of remote sensing images for Earth Sciences applications.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38105>

M

YEAR: 2

SEM: 1

ECTS: 4

DEGREE in Geological Sciences and Technologies

CONTACT: micol.rossini@unimib.it



EARTH SYSTEM MODELS IN CLIMATE CHANGE SCIENCE

LECTURER: ALBANI SAMUEL

CONTENTS

The aim of the course is to enable students to gain a basic knowledge of the climate system and its representation in numerical Earth System Models (ESMs), as a fundamental tool in the framework of climate change studies.

For all students, this course will provide basic knowledge on climate change, and it will allow them to communicate with experts in climate modeling, and make sense of climate model data that may constitute the inputs / starting point of their future work, for instance on the impacts of climate changes.

For those who are interested in pursuing modelling climate or other aspects of the physical world, this course could be good starting point, and should be complementary to more focused courses.

- The climate system and climate change
- Theoretical bases of numerical climate prediction
- Applications with the WRF regional climate model

PREREQUISITES

Physical Geography.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38111>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: samuel.albani@unimib.it

ENGINEERED NANOMATERIALS

LECTURER: ANTONINI CARLO

CONTENTS

The course covers the basic principles associated with nanoscience and nanotechnology which is necessary to understand the nanomaterials properties, and how nanomaterials can be designed and engineered. The course will span from nanotools (characterizations and fabrication methods), to physics (size dependent properties and phenomena) and chemistry (synthesis and modification), as well as applications of materials at nanometer length scales with an emphasis on recent technological breakthroughs in the field.

PREREQUISITES

Suggested: Physical Chemistry of Solid State and Surfaces (1st year, MSc degree in Materials Science).

WEBSITE <https://elearning.unimib.it/course/info.php?id=37924>

M

YEAR: 2
SEM: 1
ECTS: 6
DEGREE in Materials Science
CONTACT: carlo.antonini@unimib.it



ENVIRONMENTAL GEOCHEMISTRY

LECTURER: ROTIROTI MARCO

CONTENTS

- * Geochemical processes in the hydrosphere, atmosphere and lithosphere
- * Biogeochemical cycles
- * Pollution of different environmental matrices
- * Stable isotope geochemistry

PREREQUISITES

Basic knowledge of chemistry and geochemistry.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38110>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: marco.rotiroti@unimib.it

ENVIRONMENTAL JUSTICE AND GEOPOLITICS OF THE SEA

LECTURER: DELL'AGNESE ELENA, GRASSO MARCO

CONTENTS

After a short introduction to the most recent theoretical approaches to political geography and critical geopolitics, the course focuses first on the historical representation of the ocean as a "political and social space" and on how the sea can be framed by international geopolitical discourse, in relation to the processes of territorialisation, geo-power and extra-territoriality of marine spaces. The second part relates to the geopolitics of the deep sea and in particular it focuses on the definition, value, ownership, access, health and future state of the resource-rich and highly contested sub-surface ocean.

PREREQUISITES

An adequate grasp of the perspectives of the relevant social sciences (geography, politics, economics, law, and sociology).

Capacity of working according to multidisciplinary and interdisciplinary perspectives.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38148>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Marine Sciences

CONTACT: elena.dellagnese@unimib.it



EVOLUTION OF SOFTWARE SYSTEMS AND REVERSE ENGINEERING

LECTURER: ARCELLI FONTANA FRANCESCA, PIGAZZINI ILARIA

CONTENTS

The student will learn all the principal techniques used to support software evolution and reverse engineering. The student will be able to use different tools useful for reverse engineering, program comprehension and software maintainability.

Introduction to the principal problematics of reverse engineering, software evolution and program comprehension. Deep study of some topics with different tools experimentations.

PREREQUISITES

Knowledge of Java Language.

Knowledge of design patterns.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37957>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Science

CONTACT: francesca.arcelli@unimib.it
ilaria.pigazzini@unimib.it



EXPERIMENTAL COSMOLOGY

LECTURER: NATI FEDERICO

CONTENTS

Elements of cosmology. Cosmic Microwave Background: history and current status of measurements. The sky at millimeter and submillimeter wavelengths. Physical observables, cosmological parameters and experimental techniques.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35294>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: federico.nati@unimib.it

PROGRAM CODE: 509484

EXPERIMENTAL PHYSICS FOR AI

LECTURER: CHIRICO GIUSEPPE

CONTENTS

PREREQUISITES

WEBSITE

B

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Artificial Intelligence

CONTACT: giuseppe.chirico@unimb.it



FINANCIAL MARKETS ANALYTICS

LECTURER: FORTE GIANFRANCO

CONTENTS

The course focuses on two macro areas of topics. A first part focused on more advanced portfolio theory models, i.e. Strategic/Tactical Asset Allocation models. The focus in this first part will be more on the empirical applications of the models and the more technical data issues involved in the development of the models. In the second part the course focuses on Equity Portfolio Management issues, introducing Economic, Fundamental and Screening factor models, clarifying the relationship with the market efficiency hypothesis and the relevance of data and its quality for building investment strategies.

PREREQUISITES

There are no formal prerequisites for the course, but basic knowledge of financial theory will be useful.

Students are also expected to know the basic concepts of statistics and in particular those related to multiple linear regression models. Basic concepts of matrix algebra will also be given for granted.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37918>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Data Science

CONTACT: gianfranco.forte@unimib.it



FOUNDATIONS OF DEEP LEARNING

LECTURER: BUZZELLI MARCO, NAPOLETANO PAOLO

CONTENTS

The course consists of a theoretical part and a part of exercises. The theoretical part aims at exploring applied math, machine learning basics and deep neural networks. The practical part consists in basic and advanced exercises using deep learning frameworks.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37919>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Data Science

CONTACT: marco.buzzelli@unimib.it

FUNCTIONAL ANALYSIS

LECTURER: VERONELLI GIONA

CONTENTS

The aim of the course is to provide the basic tools of Mathematical Analysis useful in the study of the differential equations of Classical Physics and Quantum Mechanics.

Complex analysis. Special functions. Fourier series. Convolution. Fourier transform. Distributions and Dirac delta. Laplace transform. Elements of Calculus of Variations.

PREREQUISITES

Basic mathematical analysis: differential calculus for functions of one or several variables, ordinary and partial differential equations, integral calculus.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37937>

M
YEAR: 1
SEM: 1
ECTS: 6
DEGREE in Materials Science
CONTACT: andrea.raimondo@unimib.it
giona.veronelli@unimib.it



FUNDAMENTALS OF MARINE BIOLOGY

LECTURER: MAGGIONI DAVIDE, SEVESO DAVIDE

CONTENTS

This course examines different biological and ecological aspects and processes of ocean ecosystems. Topics include the distributions, abundances, life habits and interactions of marine organisms characterizing the main zones and the different systems of the marine environment. The impact of multiple stressors and the problems affecting the marine habitats are also discussed.

Processes of marine organisms, Marine systems and habitats, Functioning of Marine Ecosystems.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38161>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: davide.maggioni@unimib.it

FUNDAMENTALS OF MARINE PHYSICAL GEOGRAPHY

LECTURER: SAVINI ALESSANDRA

CONTENTS

Provide knowledge on the processes that form and shape coastal and submarine landforms, controlling their short-term and long-term evolution through time. Provide a basic knowledge about seafloor mapping techniques and methods for submarine geomorphological mapping.

- * Data and methods in Marine Geomorphology. Seafloor mapping, seafloor sampling and visual surveys: tools and survey design.
- * Coastal landforms and processes. Beach and nearshore systems, coastal sand dunes, delta and estuaries, barrier systems. Rocky coasts and coral reefs.
- * Submarine landforms and processes. Drivers of seafloor geomorphic change in submarine environment (tectonic, sedimentology, oceanography and biology). Continental shelf landforms, submarine landslides, submarine canyons and gullies, channel and fans, contouritic drifts, oceanic islands and seamounts, mid-ocean ridges, fluid-escape features, abyssal hills and plains, trenches, bioconstructions.

PREREQUISITES

Fundamentals of Mathematics, Physics and Chemistry.

<https://elearning.unimib.it/course/info.php?id=38138>

WEBSITE <https://elearning.unimib.it/course/info.php?id=38162>

M
YEAR: 1
SEM: 1
ECTS: 8/6
DEGREE in Geological Sciences and Technologies
Marine Sciences
CONTACT: alessandra.savini@unimib.it



FUNDAMENTALS OF QUANTUM MECHANICS FOR MATERIALS SCIENTISTS

LECTURER: SCALISE EMILIO

CONTENTS

- * Introduction to the quantum mechanics formalism
- * Observables, Operators and their properties
- * Quantum Models in 1D and 3D.
- * Hydrogen atom
- * Spin
- * Non-interacting Many-Particle Systems
- * Emission and Absorption of Light

PREREQUISITES

Basic physics concepts and (likely) some quantum ideas in a modern physics course.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37930>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: emilio.scalise@unimib.it

GENETIC MECHANISMS OF HUMAN DISEASE

LECTURER: MERCURIO SARA, NICOLIS SILVIA KRISTEN, RONCHI ANTONELLA

CONTENTS

The course will consist of research seminars and discussion in class of research papers concerning subjects that are part of the courses of Genetics of Development and differentiation and Human Molecular genetics.

The papers will address subjects that are part of the courses of Genetics of Development and differentiation and Human Molecular genetics, in particular:

- * The development and differentiation of the hematopoietic, muscular, and nervous systems;
- * Genetic disease, with special regard to these systems, and their modelling in mice and cells (e.g. iPS cells);
- * Genome editing approaches to the therapy of genetic disease

PREREQUISITES

A good understanding of basic genetics and molecular biology is required

WEBSITE <https://elearning.unimib.it/course/info.php?id=38888>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Biology

CONTACT: sara.mercurio@unimib.it



GALAXIES AND DYNAMICS (BLENDED)

LECTURER: DOTTI MASSIMO

CONTENTS

Introduction to N-body numerical simulations. Introduction to the physics of galaxy clusters.

Introduction to galactic dynamics. The two body problem. Introduction to direct N-body codes. Potential theory. Simulation of the collapse of a homogeneous sphere. Introduction to galaxies: morphology and dynamics. Introduction to tree-codes, Orbits in spherical and axisymmetric potentials. Introduction to the Toomre parameter and simulation of a stellar disc fragmentation. Introduction to the distribution function. Collisionless Boltzmann equation. Jeans and virial equations. Jeans theorem. Derivation of the distribution functions for spherically symmetric systems. Simulation of a Plummer sphere in equilibrium. Relaxation processes. Two-body relaxation time. Dynamical friction. Introduction to the physics of galaxy clusters.

PREREQUISITES

Undergraduate degree in physics

WEBSITE <https://elearning.unimib.it/course/info.php?id=35291>

M

YEAR: 1

SEM: 1

ECTS: 8

DEGREE in Astrophysics and Space Physics

CONTACT: massimo.dotti@unimib.it

PROGRAM CODE: F1701Q084

PROGRAM CODE: F5802Q012

GENERAL RELATIVITY

LECTURER: TOMASIELLO ALESSANDRO

CONTENTS

- 1) Principles and equations of general relativity.
- 2) Elements of differential geometry.
- 3) Black hole physics.
- 4) Elements of cosmology.

PREREQUISITES

A good understanding of basic genetics and molecular biology is required

WEBSITE <https://elearning.unimib.it/course/info.php?id=39140>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics, Astrophysics and Space
Physics

CONTACT: alessandro.tomasiello@unimib.it



PROGRAM CODE: F7401Q046

PROGRAM CODE: F7502Q013

GEOBIOLOGY

LECTURER: BASSO DANIELA MARIA, COLETTI GIOVANNI

CONTENTS

To provide the main concepts for understanding the interactions and the coevolution of biosphere, hydrosphere and geosphere.

To acquire the conceptual and operative knowledge for the study and interpretation of the modern marine environments and their reconstruction in the geological record, including the recent past.

Coevolution of geosphere and biosphere, principles of biomineralization, biogenic carbonates, bioconstruction and habitat engineers, sediments and benthos, benthic zonation, introductory biogeochemistry and proxy data in natural archives, past and ongoing global changes.

PREREQUISITES

Fundamentals of Marine Biology, Ecology and Physical geography. General Palaeontology is also suggested.

<https://elearning.unimib.it/course/info.php?id=38139>

WEBSITE <https://elearning.unimib.it/course/info.php?id=38163>

M

YEAR: 1

SEM: 1

ECTS: 8/6

DEGREE in Geological Sciences and Technologies
Marine Sciences

CONTACT: daniela.basso@unimib.it

GEOCHRONOLOGY AND ARCHEOMETRY

LECTURER: VILLA IGOR MARIA

CONTENTS

The course will deal with the main dating methods relevant for geological and archeological research. Isotopic geochronology: radioactive decay. The age equation. Rb-Sr, Sm-Nd, U-Pb, K-Ar and ^{39}Ar - ^{40}Ar methods. Statistical and systematic errors. Principles of mass spectrometry: TIMS, SIMS, PIMMS. Isotope geochemistry of Sr, Nd, Pb. Applications of isotope geochemistry to studies on provenance of sediments and archeological objects. Applications of geochemistry to the mitigation of volcanic risk.

Quaternary geochronology: radiocarbon, uranium series disequilibrium, fission tracks, thermoluminescence, dendrochronology. Other non-isotopic direct and indirect dating methods. Dating hominid evolution.

Stable isotope fractionation, isotope thermometry and paleoclimatological proxies: deuterium, carbon, oxygen, heavy elements.

Extinct and cosmogenic radionuclides.

PREREQUISITES

Chemistry, physics, geochemistry, geophysics (suggested)

WEBSITE <https://elearning.unimib.it/course/info.php?id=38108>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: igor.villa@unimib.it



GEOENERGY

LECTURER: CROSTA GIOVANNI

CONTENTS

Provide a broad framework of knowledge to geologists to address the emerging issues in the field of geo-energy and sustainability.

Energy resources are one of the most important factors for human activity and consumption of these sources has an immediate impact on the living conditions but also on the equilibrium and evolution of our planet.

The course will cover the basic aspects regarding the problems of research and exploitation of energy resources with hints about the associated risks.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38093>

M

YEAR: 2

SEM: 2

ECTS: 4

DEGREE in Geological Sciences and Technologies

CONTACT: giovannibattista.crosta@unimib.it

PROGRAM CODE: F7401Q109

GEO-HYDROLOGICAL RISK

LECTURER: DE BLASIO FLAVIO VITTORIO

CONTENTS

N/A

PREREQUISITES

N/A

WEBSITE <https://elearning.unimib.it/course/info.php?id=38112>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: fabio.deblasio@unimib.it

GRAVITATIONAL WAVE ASTROPHYSICS

LECTURER: SESANA ALBERTO

CONTENTS

Acquire basic knowledge in the field of gravitational waves, which have recently been confirmed as an extraordinary tool for understanding the universe and the objects that populate it.

At the end of the course the student:

- * will know how to learn to derive the general formula for the amplitude of a gravitational wave
- * will know the main sources of gravitational waves and the type of signals they emit
- * will know the main techniques of gravitational waves observations, and the type of signals they observe.

PREREQUISITES

None, besides the basic classes of the bachelor..

WEBSITE <https://elearning.unimib.it/course/info.php?id=31980>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics And Space Physics

CONTACT: alberto.sesana@unimib.it

HUMAN GEOGRAPHY OF SMALL ISLAND SYSTEMS

LECTURER: MALATESTA STEFANO

CONTENTS

Mainly referring to the general framework of the Island Studies, the course aims to provide a set of tools useful to the analysis of socio-spatial dynamics within island systems. Furthermore the course aims to provide tools and interpretative models useful to understand how, at local scale, human communities (privately, socially and politically) cope with socio-environmental changes, crises, conflicts and transitions by producing a set of resilient practices, knowledge and adjustments

Geography of Archipelagos and Island States; Human Geography of Islands; Human Ecology of Island Systems; Environmental challenges in Small Island States; Trans-scalar Spatial Analysis of Island Systems; Environmental Policies of Small Island States, Islands as Ecotones, Archipelago and Aquapelagos.

PREREQUISITES

N/A.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38152>

M

YEAR: 1
SEM: 2
ECTS: 6
DEGREE in Marine Sciences
CONTACT: stefano.malatesta@unimib.it



PROGRAM CODE: F1801Q110

PROGRAM CODE: F9201P031

INFORMATION RETRIEVAL

LECTURER: PASI GABRIELLA, VIVIANI MARCO, PEIKOS GEORGIOS

CONTENTS

This course aims at introducing the basic concepts, the formal models and the main techniques to define and design Information Retrieval Systems (also called Search Engines, and in particular Web Search Engines when working on the Web to the aim of retrieving Web pages) and Information Filtering (IF) systems. In particular, various techniques for the analysis and the indexing of texts will be presented, also including a basic introduction to multimedia documents indexing. Moreover, the issue of estimating the relevance of documents to a query will be addressed: several models finalised at the assessment of a numeric estimate of relevance (degree or probability) of a document to a query will be explained. The main approaches to personalized search will be presented. The course will also introduce additional applications related to text analysis and mining, such as the crawling and analysis of user generated content on Social Media (e.g. Twitter, Facebook, etc.). The important issue of the evaluation of the credibility of the content generated by users in social media will be also presented.

PREREQUISITES

Basic knowledge of statistics and of linear algebra.

<https://elearning.unimib.it/course/info.php?id=37981>

WEBSITE <https://elearning.unimib.it/course/info.php?id=37787>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Science

Theory and Technology of Communication

CONTACT: gabriella.pasi@unimib.it

marco.viviani@unimib.it

INTERNATIONAL LAW OF THE SEA

LECTURER: TANI ILARIA

CONTENTS

The aim is to provide students who have a scientific background with some basic knowledge of the international legal regime that presently applies to marine spaces, with particular emphasis on the protection of the marine environment.

The legal regime of the seas at the world basis, as resulting from the 1982 United Nations Convention on the Law of the Sea.

A regional system for the protection of the marine environment, as resulting from the 1976-1995 Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38150>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: ilaria.tani@unimib.it



INTRODUCTION TO COSMOLOGY

LECTURER: DOTTI MASSIMO

CONTENTS

Classical cosmology, Friedman models. Cosmic microwave background. Cosmological nucleosynthesis. Inflation. Structure formation and growth.

Large scale homogeneity and isotropy of the Universe. The Hubble law. The Robertson Walker

metric. The Friedmann Equation and Friedmann models. Measures of the cosmological parameters. Problems in the standard Big bang model and the inflation solution. Cosmic nucleosynthesis. Recombination. Cosmic microwave background. Collapse of the first haloes and of their baryonic components.

PREREQUISITES

Mathematics and Physics for undergraduates.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35290>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics And Space Physics

CONTACT: massimo.dotti@unimib.it

PROGRAM CODE: 509478

KNOWLEDGE REPRESENTATION AND REASONING

LECTURER: PENALOZA Nyssen Rafael

CONTENTS

PREREQUISITES

WEBSITE

M

YEAR: 1

SEM: 1+2

ECTS: 12

DEGREE in Artificial Intelligence

CONTACT: rafael.penalozyanysen@unimib.it



PROGRAM CODE: F7401Q115

LABORATORY OF ADVANCED NUMERICAL MODELLING IN EARTH SCIENCES

LECTURER: DE BLASIO FABIO VITTORIO

CONTENTS

N/A

PREREQUISITES

N/A.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38097>

M

YEAR: 2

SEM: 1

ECTS: 4

DEGREE in Geological Sciences and
Technologies

CONTACT: fabio.deblasio@unimib.it



LABORATORY OF DATA ACQUISITION

LECTURER: FUMAGALLI MICHELE, LONGOBARDI ALESSIA, ZANNONI MARIO

CONTENTS

How to write a proposal, know-how on optical instrumentations, elements of data acquisition and data reduction, best practice for the analysis of data, how to present results in a scientific report.

- Proposal writing: the structure of a successful proposal, scientific and technical elements, planning of observations
- Know-how on optical instrumentations: imaging and spectroscopy, site conditions, estimates of integration times
- Data acquisition and data reduction: from raw to science-grade data, extracting measurements from data and associated errors
- Data analysis and scientific report: how to model observations and address the goal of the proposal, reporting results
- Practicals: mini research projects using data from the Bicocca Telescope

PREREQUISITES

Undergraduate degree in physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35303>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Astrophysics And Space Physics

CONTACT: michele.fumagalli@unimib.it

LABORATORY OF DATA ANALYSIS

LECTURER: FUMAGALLI MICHELE, CANTALUPO SEBASTIANO

CONTENTS

Brief introduction on the basic principles of galaxy formation and evolution, learn how to formulate a scientific question, design and conduct a scientific experiment in astrophysics using archival observations, analysis and data mining of observations and theoretical models, how to present results in a science report.

PREREQUISITES

Undergraduate degree in physics.

Students particularly interested in a more in depth understanding of how astrophysical data are acquired are encouraged to follow the "Laboratory of data acquisition" offered in the first semester.

Students interested in deepening their understanding of galaxy formation and evolution should also consider the course "Cosmic Structure Formation".

WEBSITE <https://elearning.unimib.it/course/info.php?id=35304>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: michele.fumagalli@unimib.it



PROGRAM CODE: F7401Q113

LABORATORY OF MICROZONATION

LECTURER: CAIELLI GRAZIA MARIA

CONTENTS

N/A

PREREQUISITES

N/A

WEBSITE <https://elearning.unimib.it/course/info.php?id=38095>

M

YEAR: 2

SEM: 1

ECTS: 4

DEGREE in Geological Sciences and Technologies

CONTACT: grazia.caielli@unimib.it

LABORATORY OF MITIGATION WORK DESIGN

LECTURER: ORLANDI GIAN MARCO

CONTENTS

The objective of this course is to familiarize students with a work method for planning the hydrogeological risk mitigation works.

During the course real cases of hydrogeological risks will be analysed, to which the work method will be applied, so as to develop mitigation works projects, both independently or in a team.

PREREQUISITES

Applied Geology

WEBSITE <https://elearning.unimib.it/course/info.php?id=38096>

M

YEAR: 2

SEM: 1

ECTS: 4

DEGREE in Geological Sciences and
Technologies

CONTACT: marco.orlandi@unimib.it



LOW ENVIRONMENTAL IMPACT MATERIALS AND PROCESSES

LECTURER: ORLANDI MARCO EMILIO

CONTENTS

- * Environmentally compatible processes for the production of materials.
- * Environmentally compatible processes for the production of fine chemicals.
- * Environmentally compatible processes for energy production.
- * The concept of green chemistry.
- * The concept of biorefinery.
- * Biotechnology and energy aspects in the biorefinery context.
- * Potentially sustainable concepts for performing chemical reactions.
- * Sustainable nanomaterials.

PREREQUISITES

- * Basic knowledge of organic and inorganic chemistry, and biology
- * Basic concepts of thermodynamics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37933>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Materials Science

CONTACT: marco.orlandi@unimib.it

LOW ENVIRONMENTAL PROCESSES

LECTURER: ORLANDI MARCO EMILIO

CONTENTS

The course aims to provide the knowledge and methodological basis to define a process with low environmental impact. The course will then focus on some chemical processes that can currently be defined as having a low environmental impact.

Environmental sustainable chemical processes definitions and applications. Biorefinery concept Green Chemistry approach. Carbon economy approach. Green Chemistry approach: alternative feedstocks and starting materials, alternative synthesis and reagents, alternative reaction conditions. Biorefinery: biomass utilisation, white biotechnology, bio-fuel. Carbon economy: application of the concept. Important Case History.

PREREQUISITES

Basic knowledge of Chemistry and Biology.

WEBSITE <https://elearning.unimib.it/course/info.php?id=30901>

M

YEAR: 2

SEM: 2

ECTS: 6

DEGREE in Chemical Sciences and Technologies

CONTACT: marco.orlandi@unimib.it

MACHINE LEARNING (module of Machine Learning and Decision Models - F9101Q005)

LECTURER: STELLA FABIO ANTONIO

CONTENTS

The course contents are the following:

- * *Data Exploration* to inspect and summarize the available data and to design and develop a pre-processing workflow,
- * *Supervised Classification*, to learn a mapping from input attributes to output or target attributes to be classified or predicted,
- * *Unsupervised Classification*, to form homogeneous groups of observations and/or attributes using a given proximity measure,
- * *Association Rules*, to automatically extract rules hidden in the data with specific reference to transaction data.

PREREQUISITES

Basic knowledge on; informatics, probability calculus and statistics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37914>

M

YEAR: 1
SEM: 1
ECTS: 6 (Only if the entire course is frequented)
DEGREE in Data Science
CONTACT: fabio.stella@unimib.it



MACHINE LEARNING AND DECISION MODELS

MODULES: Decision Models (ref. F9101Q006M)
Machine Learning (ref. F9101Q005M)

LECTURER: MESSINA VINCENZINA, STELLA FABIO ANTONIO

CONTENTS

Decision Models: This module will emphasize the relevance of data in decision making. The general aim is to develop skills in mathematical modeling and in algorithms and computational methods to solve and analyze decision problems. The course will illustrate how to formulate real world problems using case studies and examples; how to use efficient algorithms – both old and new – for solving these models; and how to evaluate, draw useful conclusions and derive useful planning information from the output of these algorithms.

Machine Learning: The course contents are the following:

- * *Data Exploration* to inspect and summarize the available data and to design and develop a pre-processing workflow,
- * *Supervised Classification*, to learn a mapping from input attributes to output or target attributes to be classified or predicted,
- * *Unsupervised Classification*, to form homogeneous groups of observations and/or attributes using a given proximity measure,

Association Rules, to automatically extract rules hidden in the data with specific reference to transaction data.

PREREQUISITES

See each module.

WEBSITE <https://elearning.unimib.it/course/view.php?id=37912>

M

YEAR: 1
SEM: 1+2
ECTS: 12
DEGREE in Data Science
CONTACT: enza.messina@unimib.it
fabio.stella@unimib.it

MANAGEMENT OF ACQUATIC RESOURCES: FISHERIES

LECTURER: MANGANO MARIA CRISTINA

CONTENTS

The course will facilitate the understanding of the broad biological, social and economic aspects of fisheries science and the interplay between them with an overall ecological emphasis, by applying lessons learned and incorporation of emerging methods and data sources. The course examines key aspects and critical issues of aquatic resources management. Specifically, the course examines fishery and aquaculture productive systems focusing on ecosystem-based management approaches and innovative solutions to make both sectors more sustainable in a context of anthropogenic driven changes.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38146>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: maria.mangano@unimib.it



MARINE ENVIRONMENTAL MICROBIOLOGY

LECTURER: FRANZETTI ANDREA

CONTENTS

1. Microbial metabolisms and diversity in marine environments: diversity of bacteria and archaea in marine environments, metabolic diversity of microbes in marine environments
2. Roles of microbes in ocean processes
3. Techniques for the characterization of microbial communities in marine environments
4. Microbial marine habitats
5. Microbial aspects of environmental issues in marine environments

PREREQUISITES

Basic knowledge of microbiology

WEBSITE <https://elearning.unimib.it/course/info.php?id=38151>

M

YEAR: 1

SEM: 1

ECTS: Only if the entire course is frequented

DEGREE in Marine Sciences

CONTACT: andrea.franzetti@unimib.it

MARINE INVERTEBRATE ZOOLOGY

LECTURER: MAGGIONI DAVIDE, GALIMBERTI ANDREA

CONTENTS

Zoology deals with the study of animals (in this specific course, the invertebrate ones). There could be many ways to treat such a wide topic. In this course, the systematics aspects are reduced to the very essential aspects, while more detailed information will be provided concerning the structure, biodiversity and interactions typical of each invertebrate phylum. Bioprospecting and conservation issues will be also discussed.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38154>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Marine Sciences

CONTACT: andrea.galimberti@unimib.it

MARINE MOLECULAR BIOLOGY

LECTURER: ORLANDI IVAN, PEREIRA BOEGER WALTER ANTONIO

CONTENTS

This course introduces the basic aspects of the molecular and cellular biology of marine organisms. Topics include the methodology and applications of molecular biology as a means of examining ecosystem-wide biological processes. At completion of the course, the students should be able to define specific biological problems with corresponding molecular markers, to design compatible experimental procedures and to define the necessary analytical protocols.

Principles and applications of molecular biology tools (genomics, transcriptomics and proteomics) for the study of marine ecology.

PREREQUISITES

Undergraduate Molecular Biology and Ecology

WEBSITE <https://elearning.unimib.it/course/info.php?id=38140>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: ivan.orlandi@unimib.it



MARINE VERTEBRATE ZOOLOGY

LECTURER: DE MADDALENA ALESSANDRO, VALSECCHI ELENA AGNESE

CONTENTS

The course covers marine vertebrates' systematics, evolutionary history, anatomy, physiology, behavior, conservation and research.

The course aims to allow students to:

- 1) Recognize and be able to classify the major groups of marine vertebrates in the wild;
- 2) Learn specialized terminology and basic concepts of the zoology of these groups of organisms;
- 3) Understand selected external and internal structures which allow adaptation to the aquatic environment;
- 4) Learn about methodologies of study of these classes of organisms in the wild and measures taken for their conservation.

PREREQUISITES

Basic biology notions.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38155>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Marine Sciences

CONTACT: alessandro.demaddalena@unimib.it
elena.valsecchi@unimib.it

MATERIALS AND DEVICES FOR ENERGY ENGINEERING

LECTURER: MANFREDI NORBERTO, BINETTI SIMONA OLGA

CONTENTS

The aim of the course is the description of the structure, properties, functions and characterization of materials for solar applications. The course will also include the description of the corresponding devices.

Description of the operating principles of a photovoltaic cell and the properties of the main photovoltaic absorbers and photovoltaic devices currently on the market and in an advanced research and development phase.

Description of the main photocatalytic and photoelectrochemical processes for the production of fuels and chemical compounds from solar energy.

PREREQUISITES

Basic knowledge of chemistry (general chemistry, inorganic, organic, physical) and solid state physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37926>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: norberto.manfredi@unimib.it
simona.binetti@unimib.it



PROGRAM CODE: F1701Q098

MATHEMATICAL METHODS FOR PHYSICS

LECTURER: DESTRI CLAUDIO, BRUNO MATTIA

CONTENTS

Group theory, distributions, and their applications to theoretical physics.

Lie groups, Lie algebras; their representations. Distributions; Green's functions.

PREREQUISITES

Undergraduate degree in math or physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39141>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: claudio.destri@unimib.it
mattia.bruno@unimib.it

MATHEMATICAL METHODS IN MODERN PHYSICS

LECTURER: RICCA RENZO

CONTENTS

The taught material aims to provide students with the basic notions regarding the definitions and the fundamental results for a geometric and topological approach to the study of classical field theory, with particular emphasis on classical vortex dynamics, ideal magnetohydrodynamics and quantum hydrodynamics.

Part I. Fluid flows and diffeomorphisms, Green's identities, conservation theorems, Euler's equations, Helmholtz's conservation laws, Navier-Stokes equations, ideal magnetohydrodynamics, magnetic helicity.

Part II. Elements of knot theory, torus knot solutions to LIA, Gross-Pitaevskii equation, topological defects, helicity and linking numbers, measures of topological complexity.

PREREQUISITES

Elements of differential geometry of curves and surfaces in three-dimensional space, elements of mechanics of continuum systems, balance laws in physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37751>

M

YEAR: 1

SEM: 2

ECTS: 8

DEGREE in Mathematics

CONTACT: renzo.ricca@unimib.it



MC SIMULATION OF RADIATION DETECTORS (BLENDED)

LECTURER: CROCI GABRIELE, REBAI MARICA

CONTENTS

The objective of the course is to learn the up-to-date numeric simulation instruments presently available about the radiation matter interaction and in particular about the operation of gaseous radiation detectors.

- * MC Simulation of radiation detectors
- * Learning GEANT4
- * Learning ROOT
- * Learning Garfield.

PREREQUISITES

Physics I and Physics II.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39144>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

CONTACT: gabriele.croci@unimib.it

METALS SCIENCE AND SUSTAINABILITY

LECTURER: PITTACCIO SIMONE

CONTENTS

The teaching aims to provide a broad foundational knowledge of metallurgy and metallic materials. The learning objective is acquiring a general understanding of how chemo-physical, microstructural and technological factors can impact on the final properties of metals and alloys.

The course topics can be divided into three major blocks.

The first block includes basic chemo-physical and metallurgical phenomena that are involved in the development of phases and microstructures in metals and alloys, and characterisation methods.

The second block comprises examples of technological processes used for the synthesis and transformation of metallic materials, and for the setting of their final properties. The third block provides an overview of the main metallic material classes by composition, including classification, applications and life cycle.

PREREQUISITES

Basic knowledge of: Calculus, Thermodynamics, General Chemistry, Solid Mechanics, Crystal Structures, Elements of X-ray Diffraction, Calorimetry.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37932>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: simone.pittaccio@unimib.it

MOLECULAR ELECTRONICS AND PHOTONICS

LECTURER: MONGUZZI MARIA ANGELO

CONTENTS

The course deals with the physical principles of the properties of molecular semiconductors. Molecular crystals and quantum mechanic origins of the intermolecular forces. Carbon-based policonjugated systems: anisotropy, low-dimensional properties. Polymeric semiconductors.

- * Electronic states of policonjugated molecules and polymers.
- * Excited states in molecular crystals.
- * Electroluminescence and led devices.
- * Organic photovoltaic cells.
- * Molecular electronics and photonics.

PREREQUISITES

This course requires a good knowledge of quantum physics (time*independent and time-dependent Schroedinger Equations, perturbation theory, Fermi golden rule), structure of matter (atoms, molecules and solids) and some basic knowledge of organic chemistry.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37935>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Materials Science

CONTACT: angelo.monguzzi@unimib.it



MULTIMEDIA DATA PROCESSING

LECTURER: CORCHS SILVIA ELENA, GASPARINI FRANCESCA

CONTENTS

The course offers an introduction to multimedia signals: images, video and audio, presenting the main methods of processing, digitizing and encoding. At the beginning the course analyzes the analog to digital conversion in particular by introducing the concepts of sampling and quantization. The main processing algorithms especially for the case of digital images are shown: histogram modification, filtering and white balancing. During the practical activities the student will apply the acquired theory to audio, image and video signals.

The course provides the basis for digitizing and encoding analogic signals: images, audio and videos. It also provides the competences to develop algorithms to process, code and compress digital signals.

PREREQUISITES

None.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37783>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Theory and technology of communication

CONTACT: francesca.gasparini@unimib.it

NANOTECHNOLOGY AND INNOVATION

LECTURER: BROVELLI SERGIO

CONTENTS

The aim of the course is to provide in depth knowledge on various classes of nanomaterials that will constitute the main ingredient of future nanotechnologies. For each materials class, the synthesis approaches and the physical mechanisms underpinning their functionality will be studied in detail with particular focus on size-related processes, such as quantum and dielectric confinement. Applications of nanomaterials in various technological fields will be considered and their functioning principles will be studied, highlighting promising strategies for their design and optimization. Regulation aspects regarding health, safety and environmental aspects of nanotechnology will be discussed.

PREREQUISITES

Basic chemistry and chemical physics. Quantum mechanics, solid state physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37925>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: sergio.brovelli@unimib.it



NUCLEAR AND SUBNUCLEAR MEASUREMENTS LABORATORY I

LECTURER: BROFFERIO CHIARA, TERRANOVA FRANCESCO

CONTENTS

The laboratory course provides an introduction at graduate level of the experimental techniques employed in particle and nuclear physics, including applications to medical and environmental physics.

The students carry on a full experiment in nuclear and particle physics, including the characterization of the source, detector, front end electronics, data acquisition and analysis.

PREREQUISITES

Experimental and analysis techniques from the Bachelor level lab courses. It is strongly recommended to follow the course on Radiation Detectors, which is normally delivered almost completely before the start of the laboratory.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39116>

M

YEAR: 1

SEM: 1

ECTS: 10

DEGREE in Physics

CONTACT: chiara.brofferio@unimib.it
francesco.terrano@unimib.it

NUCLEAR AND SUBNUCLEAR MEASUREMENTS LABORATORY II

LECTURER: NUCCIOTTI ANGELO, TERRANOVA FRANCESCO

CONTENTS

In this II part, the students deepen the experimental techniques developed in the I part of this Laboratory. The experimental apparatus assembled in the previous course is now employed to perform more sophisticated measurements; here the assessment of systematic bias plays a leading role in data taking and analysis.

PREREQUISITES

Laboratory of nuclear and particle physics, I part.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39115>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

CONTACT: angelo.nucciotti@unimib.it
francesco.terranoval@unimib.it



NUMERICAL RELATIVITY

LECTURER: GIACOMAZZO BRUNO

CONTENTS

Neutron stars, binary neutron star systems and their observations, numerical relativity.

PREREQUISITES

This course requires a basic knowledge of special and general relativity. The latter can be obtained by following the Relativistic Astrophysics or General Relativity courses.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35299>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: bruno.giacomazzo@unimib.it

OCEAN MONITORING AND DATA ANALYSIS

LECTURER: COLOMBO ROBERTO, PASQUERO CLAUDIA

CONTENTS

Provide information on available oceanographic databases and how their data are gathered and stored. Provide background information on the contribution of remote sensing to ocean and coastal water monitoring. Show how data can be visualised and analysed to answer to specific questions, using statistical methods and models, with Matlab and/or Python software.

Ocean observing systems, including remote sensing, Eulerian stations, drifters and ship measurements. Ocean databases. Spatio-temporal data analysis. Modeling tools. Visualisation tools.

PREREQUISITES

Physics of the Sea

WEBSITE <https://elearning.unimib.it/course/info.php?id=38165>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences

CONTACT: roberto.colombo@unimib.it

claudia.pasquero@unimib.it

OCEAN RESOURCES LAW AND POLICY

LECTURER: SCOVAZZI TULLIO, TANI ILARIA

CONTENTS

The aim is to provide students who have a scientific background and have attended the course in “International Law of the Sea” with a basic knowledge of the international legal regime that presently applies to the exploration and exploitation of marine natural resources.

The legal regime concerning the exploration and exploitation of marine natural resources, both living and non-living, at the world basis, as provided for by the the 1982 United Nations Convention on the Law of the Sea.

PREREQUISITES

To have attended the course in “International Law of the Sea”.

WEBSITE <https://elearning.unimib.it/course/info.php?id=31002>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Marine Sciences

CONTACT: tullio.scovazzi@unimib.it

ilaria.tani@unimib.it



PROGRAM CODE: F7502Q020

PROGRAM CODE: F7401Q095

PALEOCEANOGRAPHY AND PALEOCLIMATOLOGY

LECTURER: MALINVERNO ELISA

CONTENTS

Understanding the natural variability in the climate system; knowledge of climatic variations and their causes at different time scales; study of proxies in different archives; knowledge of the main oceanographic processes in the present and in the past.

Bases of Paleoceanography and Paleoclimatology: climate system, chronology, proxies. Climatic variability and climate variations: timescales of changes. Paleoceanographic variations, as reconstructed through proxy data.

PREREQUISITES

N/A.

<https://elearning.unimib.it/course/info.php?id=38147>

WEBSITE <https://elearning.unimib.it/course/info.php?id=38103>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Marine Sciences
Geological Sciences and Technologies

CONTACT: elisa.malinverno@unimib.it



PHYSICAL CHARACTERIZATION OF MATERIALS WITH LABORATORY

LECTURER: VEDDA ANNA GRAZIELLA

CONTENTS

The course includes two parts with one final examination. The first part consists in lessons aimed at the presentation of the fundamental concepts of optical and vibrational spectroscopy of solids, together with the description of selected experimental techniques; the second part consists in an experimental activity.

Optical and vibrational spectroscopy of solids. Introduction to selected experimental techniques.

PREREQUISITES

Fundamentals of the structure of matter.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37947>

M

YEAR: 1

SEM: 1+2

ECTS: 8

DEGREE in Materials Science

CONTACT: anna.vedda@unimib.it

PHYSICAL CHEMISTRY OF SOLID STATE AND SURFACES

LECTURER: ANTONINI CARLO, BINETTI SIMONA OLGA

CONTENTS

Importance of defects on material properties, mainly in semiconductors. Elements of physical chemistry of surfaces. Adsorption phenomena: physisorption and chemisorption. Principal methods and techniques of Surface Characterization. Growth techniques of massive materials and thin film deposition procedures. Correlation of properties, defects and growth techniques.

PREREQUISITES

Main Physical Chemistry I and Materials Science topics in 1st cycle bachelor degree programs.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37936>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Materials Science

CONTACT: carlo.antonini@unimib.it
simona.binetti@unimib.it



PHYSICS AND TECHNOLOGY OF ELECTRIC DEVICES WITH LABORATORY

LECTURER: FANCIULLI MARCO, ZULLINO LUCIA

CONTENTS

The course is devoted to provide the student with the fundamentals of the physics and technology of semiconductors devices. In addition to lectures the course offers two laboratory activities dedicated to state of the art electrical characterization and simulation of the devices.

Physics of conventional electronic devices (junctions, transistors), of ultrascaled nanoelectronic devices (single electron and single atom transistors), and of emerging and novel nanoelectronic and spintronic devices for logic and memory applications, and for quantum information processing. Nanoelectronic devices (EOS, EOSFETs, Memristors) for neuroelectronic applications will be also discussed.

PREREQUISITES

Solid State Physics and Physics and Semiconductors.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37929>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: marco.fanciulli@unimib.it

PHYSICS OF HOMOGENEOUS AND NANOSTRUCTURED DIELECTRICS

LECTURER: PALEARI ALBERTO MARIA FELICE

CONTENTS

The course starts from the description of polarization effects in materials to achieve the consciousness of the physical mechanisms responsible for the refractive index dispersion, optical absorption, light emission yield and nonlinear response in homogeneous, composite, and nanostructured systems as a function of materials features, structural order and disorder, and working parameters as temperature, stress, and light intensity. The lectures highlight the main properties making silica-based oxides key dielectric materials in photosensitive systems for the fabrication of fibre filters and fibre sensors, in optical amplifiers as doped active glasses, and in even more complex systems via nonlinear response.

PREREQUISITES

Basic knowledge of electromagnetism.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37943>

M

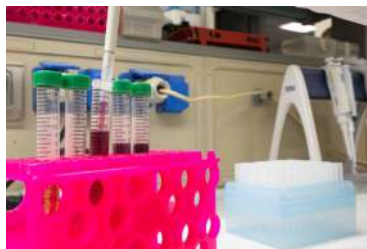
YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Materials Science

CONTACT: alberto.paleari@unimib.it



PHYSICS OF SEMICONDUCTORS

LECTURER: FANCIULLI MARCO

CONTENTS

The main objective of the course is to provide an overview of the subject and a solid background for further specialization in the area of electronics and optoelectronics, sensors, energy harvesting and production, and supervised laboratory research. After a summary of technologically relevant materials and their properties and a reminder of solid-state physics concepts, such as crystal structure, lattice vibrations and band structure, semiconductor specific topics such as effective mass and its experimental determination, k dot p perturbation method, point defects and their structural, thermodynamic and electronic properties, charge statistic in intrinsic and extrinsic semiconductors, optical properties, charge transport, semiconductors in equilibrium and non-equilibrium conditions will be presented as the core of the course.

Semiconductor physics: electronic, optical, and transport properties.

PREREQUISITES

Quantum Mechanics. Solid State Physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37944>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Materials Science

CONTACT: marco.fanciulli@unimib.it

PROGRAM CODE: F7502Q005

PROGRAM CODE: F7401Q097

PHYSICS OF THE SEA

LECTURER: PASQUERO CLAUDIA

CONTENTS

Provide basic knowledge of the physics of the oceans. Show the usefulness of mathematical and physical models for the description and the understanding of geophysical fluid dynamics.

In the first part of the course fundamental physical properties of the ocean will be introduced. The second part will be basic geophysical fluid dynamics, with the discussion of solutions to approximations relevant for the description of the ocean circulation and waves. In the laboratory sessions, experiments and problems will be presented to better visualise and understand the main topics of the course.

PREREQUISITES

None.

<https://elearning.unimib.it/course/info.php?id=38153>

WEBSITE <https://elearning.unimib.it/course/info.php?id=30859#en>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Marine Sciences
Geological Sciences and Technologies

CONTACT: claudia.pasquero@unimib.it



PLASMA PHYSICS II

LECTURER: NOCENTE MASSIMO

CONTENTS

The course aims at providing the students an introduction to plasma physics and thermo-nuclear fusion.

Introduction to plasma physics, charge particle motion in a magnetic field, introduction to collisional processes in plasmas, introduction to the collisional kinetic theory, basics of nuclear fusion in tokamak devices, physics principles of selected diagnostic techniques for tokamak plasmas.

PREREQUISITES

Mathematics and physics courses of the Bachelor Degree in Physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39102>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: massimo.nocente@unimib.it

QUANTITATIVE GEORISK ANALYSIS

LECTURER: FRATTINI PAOLO

CONTENTS

The course aim at providing concepts and methodologies for the analysis, the evaluation and the mitigation of geological risks.

Definition of hazard, vulnerability and risk. Description and assessment of flood risk, seismic risk, landslide risk and snow avalanche risk. Introduction on coastal risks and volcanic risk.

PREREQUISITES

None

WEBSITE <https://elearning.unimib.it/course/info.php?id=38126>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: paolo.frattini@unimib.it

PROGRAM CODE: F1701Q135
PROGRAM CODE: F1701Q042

QUANTUM FIELD THEORY I

LECTURER: GIUSTI LEONARDO

CONTENTS

To give the conceptual and technical tools of relativistic quantum field theories for studying fundamental interactions.

Path integral formulation of relativistic quantum field theories.

PREREQUISITES

Quantum mechanics and Theoretical physics I and II.

WEBSITE <https://elearning.unimib.it/course/info.php?id=31991>
<https://elearning.unimib.it/course/info.php?id=39132>

M

YEAR: 1
SEM: 2
ECTS: 6
DEGREE in Physics
Astrophysics And Space Physics
CONTACT: leonardo.giusti@unimib.it



QUANTUM FIELD THEORY II

LECTURER: PENATI SILVIA

CONTENTS

Complete the study of QFTs by developing the functional approach to gauge theories, which describe fundamental interactions. Deepen the knowledge of the main properties of QED and QCD. Become familiar with advanced topics in QFT.

Functional approach to gauge theories. Perturbative renormalization of QED and QCD.

Renormalization group for gauge theories. Anomalies.

PREREQUISITES

General Relativity, Theoretical Physics I,II, Quantum Field Theory I

WEBSITE <https://elearning.unimib.it/course/info.php?id=39131>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

CONTACT: silvia.penati@unimib.it

QUANTUM GRAVITY

LECTURER: NOCENTE MASSIMO

CONTENTS

The course aims at providing the students an introduction to plasma physics and thermo-nuclear fusion.

Introduction to plasma physics, charge particle motion in a magnetic field, introduction to collisional processes in plasmas, introduction to the collisional kinetic theory, basics of nuclear fusion in tokamak devices, physics principles of selected diagnostic techniques for tokamak plasmas.

PREREQUISITES

Mathematics and physics courses of the Bachelor Degree in Physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39138>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: massimo.nocente@unimib.it

PROGRAM CODE: F1701Q151

PROGRAM CODE: F5302Q037

QUANTUM MATERIALS

LECTURER: SANGUINETTI STEFANO

CONTENTS

The physical description of the materials is rooted in quantum mechanics, which describes how atoms bond between each other and how electrons interact. Although these quantum effects can in many cases be approximated by a classical description at the macroscopic level, there are material systems where quantum effects remain evident over a wider range of energy and length scales. Such quantum materials include superconductors, graphene, topological insulators, Weyl semimetals. Many of them derive their properties from reduced dimensionality, in particular from confinement of electrons to two-dimensional sheets. Moreover, they tend to be materials in which electrons cannot be considered as independent particles but interact strongly and give rise to collective excitations known as quasiparticles. This course will introduce the electronic properties of quantum materials and examines how its entanglement and topology give rise to a rich variety of quantum states and phases.

Topological Effects, Integer Quantum Hall Effect, Topological Insulators, Weyl semimetals, Superconductivity

PREREQUISITES

Electromagnetism, quantum mechanics, solid state physics

WEBSITE <https://elearning.unimib.it/course/info.php?id=37946>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

Materials Science

CONTACT: stefano.sanguinetti@unimib.it

RADIATION MATTER INTERACTION

LECTURER: MARTINI MARCO

CONTENTS

Aim of the course is to give the basis of the mechanisms of energy transfer from ionizing radiation to materials and to introduce some applications based on the interaction of ionizing radiation with materials

Fundamental nuclear physics. Radioactivity. Sources of ionizing radiation. Energy transfer from radiation to materials. Application of experimental techniques based on the interaction radiation-matter.

Sources of ionizing radiation. Energy transfer from radiation to materials. Defects induced by radiation. Experimental techniques for the study of the effects of the interaction radiation-matter on the physical properties of the materials: nuclear techniques, as Accelerator Mass Spectrometry (AMS), luminescence techniques and X-ray Fluorescence (XRF), with particular focus on archaeometric applications, like dating and ancient materials identification and measurements.

PREREQUISITES

Basic knowledge of physics of matter.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37942>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Materials Science

CONTACT: m.martini@unimib.it



RADIATIVE PROCESSES

LECTURER: COLPI MONICA

CONTENTS

- ◇ The electromagnetic spectrum
- ◇ The multi-wavelength Universe
- ◇ Thermal plasma - Black body - Bremsstrahlung
- ◇ Synchrotron emission and self-absorption
- ◇ Direct Compton and Inverse Compton
- ◇ Atomic structure and radiative transitions
- ◇ Relativistic beaming
- ◇ Theory of accretion onto black holes
- ◇ Active Galactic Nuclei: phenomenology and interpretation - Inference of their fundamental physical parameters

PREREQUISITES

Classical mechanics, classical electro-magnetism.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35302>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: monica.colpi@unimib.it

PROGRAM CODE: F5801Q047

RELATIVISTIC ASTROPHYSICS

LECTURER: SESANA ALBERTO

CONTENTS

N/A

PREREQUISITES

N/A

WEBSITE

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Astrophysics and Space Physics

CONTACT: alberto.sesana@unimib.it

REPRESENTATION THEORY

LECTURER: WEIGEL THOMAS STEFAN

CONTENTS

The course is aimed to present the contents and the fundamental methods, as well as some noteworthy applications of the ‘classical’ theory of representations of finite groups. The expected learning outcomes include: the knowledge of the main results in the representation theory of finite groups, as well as the ability to apply them on concrete examples. Semisimple rings and modules. Modules and representations. Characters of finite groups. Tensor products of representations. Permutation representations and applications. Direct products. Induction and restriction of representations. Clifford Theory.

PREREQUISITES

It is recommended an a priori knowledge of the standard contents of first and second year Algebra courses, plus some extra knowledge of field theory.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37761>

M

YEAR: 1

SEM: 1

ECTS: 8

DEGREE in Mathematics

CONTACT: thomas.weigel@unimib.it



SEDIMENTARY PETROLOGY

LECTURER: ANDO' SERGIO, GARZANTI EDUARDO ALDO FRANCO, RESENTINI ALBERTO

CONTENTS

This course in Sedimentary Petrography is dedicated to our MSc and PhD Students, world-wide interested in heavy mineral identification and provenance studies of sediments and sedimentary rocks carried out with classical optical methods and supported by innovative methods as Raman spectroscopy.

- * Introduction to Sedimentary Petrography
- * Sampling in the field
- * Laboratory for heavy mineral separation
- * Petrography of siliciclastic detritus
- * Heavy-mineral studies
- * Physical processes
- * Chemical processes
- * How to count in provenance studies and data processing
- * Geochronology of detritus
- * Applications to Petroleum Geology.

PREREQUISITES

A good knowledge of mineralogy and petrography is necessary. A complementary course in Basin analysis for a better understanding of plate tectonic and regional geology is also important. A real interest in learning techniques for the study of the mineralogy of sediments in the laboratory of sedimentology and sedimentary petrography is strongly recommended. Students interested in petroleum geology are strongly encouraged to follow this course.

WEBSITE <https://elearning.unimib.it/course/info.php?id=38133>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Geological Sciences and Technologies

CONTACT: sergio.ando@unimib.it
eduardo.garzanti@unimib.it

SEMICONDUCTORS PHYSICS

LECTURER: FANCIULLI MARCO

CONTENTS

The main objective of the course is to provide an overview of the subject and a solid background for further specialization in the area of electronics and optoelectronics, sensors, energy harvesting and production, and supervised laboratory research. After a summary of technologically relevant materials and their properties and a reminder of solid-state physics concepts, such as crystal structure, lattice vibrations and band structure, semiconductor specific topics such as effective mass and its experimental determination, k dot p perturbation method, point defects and their structural, thermodynamic and electronic properties, charge statistic in intrinsic and extrinsic semiconductors, optical properties, charge transport, semiconductors in equilibrium and non-equilibrium conditions will be presented as the core of the course.

Semiconductor physics: electronic, optical, and transport properties.

PREREQUISITES

Quantum Mechanics. Solid State Physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39103>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

CONTACT: marco.fanciulli@unimib.it



SLOPE INSTABILITY

LECTURER: AGLIARDI FEDERICO

CONTENTS

Advanced knowledge of processes and mechanisms of natural and engineered slope instability; ability to recognize and characterize different types of slope instabilities; ability to use stability analysis methods and tools to solve practical problems.

Theory and techniques for the recognition, characterisation and modelling of slope instability processes in soils and rocks.

PREREQUISITES

Geology, hydrogeology, engineering geology

WEBSITE <https://elearning.unimib.it/course/info.php?id=30885>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Geological Sciences and
Technologies

CONTACT: federico.agliardi@unimib.it



SOCIAL MEDIA ANALYTICS

LECTURER: FERSINI ELISABETTA, VIVIANI MARCO, TOCCU MAURIZIO

CONTENTS

At the end of the course, the student will have learned the main concepts underlying the management of data originating in social media (access, pre-processing, modeling) and their subsequent analysis. The student will be able, in particular, to collect, process and analyze data from the main social media, using the most suitable technologies for the purpose. S/he will also be able to provide a representation of complex social structures in order to extract useful information.

The Social Web: introduction and related terminology;

- * Retrieving data in social media.
- * Representing complex social data structures (graph theory and networks);
- * Description of some open issues (information diffusion and credibility);
- * Social Network Analysis;
- * Subjectivity and sentiment analysis, irony detection;
- * Named Entity Recognition and Linking;
- * Visualization of social media data: open issues and techniques.

PREREQUISITES

Basic knowledge of the principles of linear algebra, statistics, programming, relational databases, and NoSQL.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37906>

M

YEAR: 2
SEM: 1
ECTS: 6
DEGREE in Data Science
CONTACT: elisabetta.fersini@unimib.it
marco.viviani@unimib.it



SOLID STATE AND SURFACE PHYSICAL CHEMISTRY

LECTURER: BINETTI SIMONA OLGA

CONTENTS

Importance of defects on material properties, mainly in semiconductors. Elements of physical chemistry of surfaces. Adsorption phenomena: physisorption and chemisorption. Principal methods and techniques of Surface Characterization. Growth techniques of massive materials and thin film deposition procedures. Correlation of properties, defects and growth techniques.

PREREQUISITES

Physical Chemistry in 1st cycle bachelor's degree programs and Physical chemistry of solid state

WEBSITE <https://elearning.unimib.it/course/info.php?id=38014>

M

YEAR: 2

SEM: 2

ECTS: 6

DEGREE in Chemical Sciences and Technologies

CONTACT: simona.binetti@unimib.it

SOLID STATE PHYSICS

LECTURER: BERGAMASCHINI ROBERTO, MIGLIO LEONIDA

CONTENTS

A first part of the course is devoted to the treatment of simpler phenomena, as described in terms of non-interacting particles (Electrons or phonons), with particular attention in teaching the skill of developing analytical models , which allow to solve complicated problems by ingenious simplifications. The second part analyzes more complex phenomena, generated by the interaction among particles, which give rise to significant macroscopic properties of the perfect and infinite solid. In this part, the focus is placed on the understanding of non-intuitive concepts and the ideal line of reasoning, preferring - also here - the methodological approach rather than the taxonomic one. The complementation of a main text with several others, depending on the topic, is an important aspect of the teaching method , that is, to acquire the habit of consulting different sources and comparing them critically.

PREREQUISITES

- * Atomic and molecular quantum physics;
- * Elementary introduction to Solid State Physics;
- * A short course in advanced calculus.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37945>

M

YEAR: 1
SEM: 1+2
ECTS: 8
DEGREE in Materials Science
CONTACT: roberto.bergamaschini@unimib.it
leo.miglio@unimib.it



SOLIDO STATE AND ELECTRONIS LABORATORY II

LECTURER: BASCHIROTTA A., DE MATTEIS M., PEZZOLI F., SANGUINETTI S.

CONTENTS

For the students of solid-state-oriented, the course consist in a laboratory experience performed by a study group of two or three students

For the student electronics-oriented, the course consists in the full design of an analog CMOS circuit by measn of the simulation software Cadence.

PREREQUISITES

Graduate in physics or equivalent.

WEBSITE <https://elearning.unimib.it/course/info.php?id=32105>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

CONTACT: andrea.baschirotto@unimib.it

STATISTICAL MECHANICS

LECTURER: PASQUETTI SARA

CONTENTS

At the end of the course students should be familiar with the basic ideas of Statistical Mechanics such as the statistical approach to the derivation of the equation of states for classical and quantum gases, the theory phases transitions and of critical phenomena.

Statistical ensembles, derivation of the equation of state for classical and quantum gases, theory phases transitions, critical phenomena and renormalization group.

PREREQUISITES

N/A.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39123>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: sara.pasquetti@unimib.it



STATISTICAL THERMODYNAMICS OF MATERIALS

LECTURER: BERGAMASCHINI ROBERTO, MONTALENTI FRANCESCO CIBRO M.

CONTENTS

The main goal of the Course is to provide to the students some key theoretical/computational tools for approaching at the atomic scale thermodynamics and kinetics of solids.

Summary of basic concepts in classical statistical mechanics, adiabatic approximation, classical approximation for the motion of nuclei, ab initio and classical molecular dynamics, scientific coding with Matlab, implementation in Matlab of a molecular dynamics code, application of the molecular dynamics code, configurational Monte Carlo, implementation of a configurational Monte Carlo code, kinetic Monte Carlo, transition state theory.

PREREQUISITES

Basic classical and quantum mechanics. Knowledge of the Boltzmann distribution.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37927>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Materials Science

CONTACT: roberto.bergamaschini@unimib.it
francesco.montalenti@unimib.it

STELLAR ASTROPHYSICS

LECTURER: COLPI MONICA

CONTENTS

The aim is at providing the tools for understanding the physics of stars, from their formation in the interstellar medium to their death as collapsed objects. These studies find their application within the nascent field of gravitational wave astrophysics and in the context of galaxy formation and evolution.

Introduction to stellar astrophysics: formation, structure and evolution.

PREREQUISITES

Calculus, Classical Mechanics, Electromagnetism, Condensed Matter, Quantum Mechanics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=35300>

M

YEAR: 1

SEM: 1

ECTS: 8

DEGREE in Astrophysics And Space Physics

CONTACT: monica.colpi@unimib.it



STREAMING DATA MANAGEMENT AND TIME SERIES ANALYSIS

LECTURER: CANDELIERI ANTONIO, PELLEGGATTI MATTEO

CONTENTS

The course illustrates methods and applications for managing, analysing and forecasting - possibly streaming - time series.

Beside data managing applications, our lessons cover both linear (ARIMA, VAR, state-space/Kalman filter) and nonlinear (neural networks, support vector machine) methods. The student who successfully follows this course will be able to manage streaming data and select, identify and implement the time series model fit to the data and the problem under analysis.

Streaming data management, linear-filter based models (ARIMA, VAR), unobserved component models (state-space form/Kalman filter), non-linear methods (neural networks, support vector machines, nearest neighbors).

PREREQUISITES

Attending students should know statistical inference and R.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37907>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Data Science

CONTACT: antonio.candelieri@unimib.it

PROGRAM CODE: F1701Q140

PROGRAM CODE: F5302Q012

SURFACES AND INTERFACES

LECTURER: MIGLIO LEONIDA

CONTENTS

The course has two targets: on the one hand, to complete the knowledge acquired during the courses of Solid State Physics, answering the fundamental question: what happens to the properties of a perfect and infinite solid when the lattice periodicity ends at a surface? On the other hand, it is intended to provide the basis for all applications of Semiconductor Physics, Physics of Electronic Devices and Nanotechnologies, inevitably involving surfaces, interfaces and epitaxial depositions. The approach is both theoretical and experimental.

PREREQUISITES

Advanced Course in Solid State Physics.

<https://elearning.unimib.it/course/info.php?id=37940>

WEBSITE <https://elearning.unimib.it/course/info.php?id=39126>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

Materials Science

CONTACT: leo.miglio@unimib.it

PROGRAM CODE: F5302Q008

PROGRAM CODE: F5401Q071

SYNTHESIS AND SPECIAL ORGANIC TECHNIQUES IN MATERIALS CHEMISTRY

LECTURER: PAPAGNI ANTONIO

CONTENTS

Overview on the strategies for the preparation of organic materials with specific optical and electronic properties exploitable in the field of photonics, organic semiconductors and on the synthesis of principal polymers with application as organic conductors or electroluminescent devices. An overview on basic concepts organic photochemistry and its application to organic synthesis.

PREREQUISITES

For an optimum understanding of the topic treated, a consolidated organic chemistry background is required together with basic knowledge on the optical and electronic properties of polyconjugated organic molecules and polymers.

<https://elearning.unimib.it/course/info.php?id=37928>

WEBSITE <https://elearning.unimib.it/course/info.php?id=38024>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Materials Science
Chemical Sciences and Technologies

CONTACT: antonio.papagni@unimib.it



TECHNOLOGICAL INFRASTRUCTURES FOR DATA SCIENCE

LECTURER: CIAVOTTA MICHELE, MELAN RICCARDO

CONTENTS

The course aims at providing a solid understanding of the technological platforms (sensors and networks) which allow the collection of data in an IoT environment, as well as of the computing platforms (architectures, algorithms and infrastructures) which can be used to analyse those data.

The exercises will provide the student with the basic capabilities necessary to interact with such platforms.

Sources of sensor data, quality of sensor data, data collection networks, sensor management platforms. Data processing architectures, Infrastructure Management, Big Data Platforms for data Science, platform examples.

PREREQUISITES

None

WEBSITE <https://elearning.unimib.it/course/info.php?id=31238>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Data Science

CONTACT: michele.ciavotta@unimib.it

TEXT MINING AND SEARCH

LECTURER: LULLI GUGLIELMO, VIVIANI MARCO, UPADHYAY RISHABH
GYANENDRA

CONTENTS

The aim of the course is to provide an introduction to the fundamental concepts related to Text Representation and Text Mining techniques; moreover, in the course some Text Mining applications will be presented: Text Classification and Clustering, Topic Modelling, and Text Summarization. An introduction to Search Engines and Recommender Systems will be provided.

This course will first provide the definition of Text Mining and will point out the basic differences between Data Mining and Text Mining.

The course will then introduce some tasks involved by Text Mining, which include Text Summarization and Text Classification. The issues of text pre-processing and analysis, and of text indexing and representation will be addressed. Then the course will introduce the previously mentioned tasks. Some open source software for Text Mining will be introduced and practiced.

PREREQUISITES

Basic knowledge of statistics and of programming languages.

WEBSITE <https://elearning.unimib.it/course/info.php?id=37923>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Data Science

CONTACT: guglielmo.lulli@unimib.it
marco.viviani@unimib.it

PROGRAM CODE: 509482

THEORETICAL AND COMPUTATIONAL LINEAR ALGEBRA

LECTURER: BEIRAO DA VEIGA LOURENCO

CONTENTS

PREREQUISITES

WEBSITE

B

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Artificial Intelligence

CONTACT: lourenco.beirao@unimib.it



THEORY AND PHENOMENOLOGY OF FUNDAMENTAL INTERACTION

LECTURER: RE EMANUELE

CONTENTS

Provide the fundamental bases of the Standard Model, in the electroweak and strong sector, the tools for cross-section and decay-rate calculations. Deepen the knowledge of the phenomenology of the fundamental particles.

Introduction to the Standard Model of the electroweak and strong interactions: the $SU(2) \times U(1) \times SU(3)$ model. The spontaneous symmetry breaking, the Higgs boson, and the phenomenology of the strong and electroweak interactions.

PREREQUISITES

Basics knowledge of Quantum Field Theory.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39127>

M

YEAR: 1

SEM: 2

ECTS: 6

DEGREE in Physics

CONTACT: emanuele.re@unimib.it



THEORY OF CONDENSED MATTER I

LECTURER: BERNASCONI MARCO

CONTENTS

To provide an introduction to the study of the electronic structure of solids beyond the independent electrons approximation. To provide an introduction to the magnetic properties of solids.

The Hartree-Fock equation and the dielectric properties of the electron gas. Second quantization. The homogeneous electron gas. Density Functional Theory and its applications to the electronic structure of solids. Magnetic properties of insulators and metals.

PREREQUISITES

The courses of Quantum Mechanics and Structure of Matter of the first level degree in Physics.

WEBSITE <https://elearning.unimib.it/course/info.php?id=39129>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: marco.bernasconi@unimib.it

THEORY OF QUANTUM INFORMATION AND QUANTUM COMPUTING

LECTURER: RE EMANUELE

CONTENTS

Computing and Quantum Technologies: entanglements, Bell's inequalities, qubits and their physical realization, examples of quantum circuits and elementary algorithms.

- * Basic elements of quantum mechanics
- * Entanglement and Bell's inequalities
- * Quantum information
- * Qubits
- * Quantum circuits
- * Simple example of quantum algorithms
- * Examples of quantum correcting codes
- * Physical realization of qubits

PREREQUISITES

Knowledge of Quantum Mechanics at the level of the Bachelor degree (the basic notions necessary for this course will be reviewed).

WEBSITE <https://elearning.unimib.it/course/info.php?id=39146>

M

YEAR: 1

SEM: 1

ECTS: 6

DEGREE in Physics

CONTACT: emanuele.re@unimib.it



THERMODYNAMICS AND KINETICS OF MATERIALS

LECTURER: MUSTARELLI PIERCARLO

CONTENTS

The aim of the course is to provide students with the knowledge and skills necessary to master the complex mechanisms and processes that underlie the phase transformations of materials, both concerning the thermodynamic aspects and the kinetic ones. The knowledge and skills acquired will be applied to some case studies of technological relevance in the field of functional materials.

- * Thermodynamics and kinetics of solids.
- * Phase transformation processes and the kinetic mechanisms (diffusion, transport) that are at their base.
- * Fundamentals of some spectroscopic techniques able to investigate the correlations between structure, dynamics and functional properties of some classes of solids.

PREREQUISITES

Basic thermodynamics. Basic crystallography.

<https://elearning.unimib.it/course/info.php?id=38023>

WEBSITE <https://elearning.unimib.it/course/info.php?id=37941>

M

YEAR: 1/2

SEM: 1

ECTS: 6

DEGREE in Materials Science
Chemical Sciences and Technologies

CONTACT: piercarlo.mustarelli@unimib.it

PROGRAM CODE: F1801Q156

PROGRAM CODE: F9201P210

UBIQUITOUS, PERVASIVE & CONTEXT-AWARE COMPUTING

LECTURER: AGOSTINI ALESSANDRA

CONTENTS

The course introduces students to the main principles of the Ubiquitous Computing research area and, successively, focusses on those themes related to the definition, modeling, and use of contextual information in designing and developing ubiquitous/pervasive and context-aware technologies.

An overview of the various accepted meaning of Context and Context-Awareness will be presented; then the course focusses on the definition and use of those contextual information asking for complex representations (e.g., those information related to the user's activity and his/her preferences).

PREREQUISITES

A good knowledge of the basis of ICT, web technology & app.

<https://elearning.unimib.it/course/info.php?id=37963>

WEBSITE <https://elearning.unimib.it/course/info.php?id=37776>

M

YEAR: 2

SEM: 1

ECTS: 6

DEGREE in Computer Science
Theory and Technology of Communication

CONTACT: alessandra.agostini@unimib.it



FOR FURTHER INFORMATION, PLEASE CONSULT OUR WEBSITE: WWW.UNIMIB.IT

IT'S IMPORTANT TO FOLLOW ALL UPDATE ON
THE WEBSITE: [HTTPS://ELEARNING.UNIMIB.IT](https://ELEARNING.UNIMIB.IT)

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