UNIVERSITY OF L'AQUILA

Department of Physical and Chemical Sciences

1^{st} Cycle Degree in

CHEMISTRY AND MATERIALS SCIENCES

Laurea in SCIENZE E TECNOLOGIE CHIMICHE E DEI MATERIALI

Course Catalogue

Academic year starts the last week of September and ends the first week of June.
1^{st} Semester - *Starting date:* last week of September, *end date*: 3^{rd} week of January
2^{nd} Semester - *Starting date:* last week of February, *end date:* 1^{st} week of June
Exams Sessions: I) from last week of January to 3^{rd} week of February, II) from 2^{nd} week of June to end of July, III) from 1^{st} to 3^{rd} week of September

Comprehensive Scheme of 1^{st} Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES"				
YEAR	**CODE**	**COURSE**	**Credits (ECTS)**	**Semester**
I	F0006	General and Inorganic Chemistry	12	1 and 2
	F0042	General Physics	12	1 and 2
	F0182	Mathematics	12	1 and 2
	F0056	Basic Practice in Chemistry	9	1 and 2
	F0043	Laboratory of General Physics	6	2
	F0187	Computational Methods	6	2
		English	3	1
II	F0283	Analytical Chemistry I with Laboratory	9	1
	F0298	Analytical Chemistry II with Laboratory	9	2
	F0303	Physical Chemistry I with laboratory	9	2
	F0288	Organic Chemistry I with Laboratory	9	1
	F0293	Organic Chemistry II with Laboratory	9	2
	F0092	Macromolecular Chemistry	9	2
	F0091	Physics of Matter	6 or 9	1
	F0078	Materials Science	6 or 9	1
III	F0093	Biochemistry	6	1
	F0094	Methods of Molecular Structure Investigation	6	1
	F0100	Environmental Chemistry	6	1
	F0308	Physical Chemistry II with laboratory	9	1
	F0096	Medicinal Chemistry	6	1
	F0198	Solid State Physics with Laboratory	9	2
	F0188	Physics of Semiconductors and Devices with Laboratory	9	2
		Free choice Course/Courses	12	1 or 2
		Placement	6	1 or 2
		Thesis	6	2

Programme of “CHIMICA GENERALE ED INORGANICA” *“GENERAL AND INORGANIC CHEMISTRY”*		
F0006, Compulsory **1st Cycle Degree in “CHEMISTRY AND MATERIALS SCIENCES”, 1st year, 1st and 2nd semester**		
Number of ECTS credits: 12 (Workload: 300 hours, 1 credit = 25 hours)		
Teachers: Massimiliano ASCHI – Aldo DOMENICANO		
1	Course objectives	The goal of this course is to provide the students with the basic concepts of the general chemistry. On successful completion of this module, the student should be familiar with the basic concepts of chemical bond and chemical equilibrium.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Atomic structure, Periodic properties and the periodic table, chemical bond and molecular structure, weak interactions, gas, liquids and solids, laws of thermodynamics, chemical equilibrium between pure species and in solution, properties of the solutions, short background in electrochemistry and chemical kinetics. On successful completion of this module the student should - be able to predict the structure of any molecule and the hybridization of the related atoms; - be able to provide the name of the most common chemical substances; - have knowledge and understanding of the principles of chemical equilibrium and the related applications; - demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notions of mathematics and, possibly, of elementary physics.
4	Teaching methods and language	Lectures. Language: Italian and English upon request Ref. Text books The student can select one of these books: • Peter W. Atkins and Loretta Jones “Principi di Chimica” Zanichelli Editore • John Kotz, Paul jr. Treichel, Gabriela C. Weaver “Chimica”, Edises • Maurizio Casarin, e altri “Chimica Generale ed Inorganica”, EdiErmes
5	Assessment methods and criteria	Oral exam.

Programme of “FISICA GENERALE” *“GENERAL PHYSICS”*		
F0042, Compulsory **1st Cycle Degree in “CHEMISTRY AND MATERIALS SCIENCES”, 1st year, 1st and 2nd semester**		
Number of ECTS credits: 12 (workload is 300 hours:1 credit = 25 hours)		
Teacher: Patrizia MONACHESI		
1	Course objectives	Providing the analytic description of the fundamental laws governing the phenomena interpreted by classical physics. Stimulating the student to understand the general principles governing physical phenomena and to learn how to represent them quantitatively and by mathematical expressions. Accustoming the student to the “scientific” approach to observable phenomena.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Classical Mechanics: Kinematics and Dynamics of point and systems with related laws and principles. The principle of relativity: Galileian invariance, validity of the classical mechanics and the velocity of light (basics). Conservation laws of mechanical quantities mass, energy, momentum, angular momentum. Connection with Kepler’s laws. Fluido-static and dynamics (basics), flux through open and close surface. Thermodynamics: temperature and heat, thermodynamic variables and state equations, first and second principle, state functions. Gas kinetic theory, energy equipartition theorem and degrees of freedom. Classical Electromagnetism: Electric charge, electric force and field in static conditions, electrostatic work and potential, discrete and continuous charge systems. Dielectric and conducting properties of matter, insulators and metals in the Periodic Table of Elements (basics). Electric capacity and energy storage. Moving charges: classical model for resistivity

		and conductivity of a conductor. Electric current (continuous), circuital elements and simple circuits. Origin of the magnetic force, static magnetic field of simple current distributions. Magnetic properties of matter (basics). Time-variable electromagnetic field and its oscillations. Waves properties (basics), Electromagnetic waves and spectrum, Maxwell equations (basics); light and photons. Technical tutorials: meaning and basic use of derivative, integral, path integral, basic vector calculus, vector operators (basics) necessary to understand and handle the module's contents. On successful completion of this module, the student should - have profound knowledge of: qualitative (i.e. dimensions) and quantitative (i.e. units) relations among physical variables; meaning and use of scalar and vector variables; difference among linear, quadratic and exponential behavior of a physical quantity; carrying out a manual plot of a physical quantity out from a data table (single variable function) . - have knowledge and understanding of: fundamental laws and principles of classical physics, especially general conservation laws. - understand and explain a (simple) physical phenomenon on the basis of known physical principles - understand a question about the major topics of the course - demonstrate skill in representing a physical phenomenon by equations and/or graphs and ability to draw conclusions on the properties of the fundamental variables involved in the phenomenon. - demonstrate capacity for reading and understanding texts containing scientific and/or quantitative informations of related or subsequent courses.
3	Prerequisites and learning activities	The student is strongly advised to know and handle Euclidean geometry, algebra, trigonometry at undergraduate level. Extra learning activity is recommended to students with large gaps in the above topics. The knowledge of physics may be limited to a very few concepts at the module's start: a regular learning activity should bring the student to a successful fulfilment of the course.
4	Teaching methods and language	Regular and interactive lectures, numerical exercises, individual and team work mostly on graphs and numerical solutions, home work (suggested). Language: Italian Ref. Text books Any general Physics text book (better in Vol.1 and 2 edition) at graduate level, e.g.: Mencuccini C. e Silvestrini V., "Fisica 1, Fisica 2", Liguori editore; Halliday D., Resnik R., Walker J., "Physics 1, 2" , John Wiley & Sons editor (English), CEA editore (Italian)
5	Assessment methods and criteria	Written and oral exam.

Programme of "ISTITUZIONI DI MATEMATICHE "
"*MATHEMATICS*"

F0182, Compulsory
First Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 1st year, 1st and 2nd semester

Number of ECTS credits: 12 (workload is 300 hours; 1 credit = 25 hours)

Teachers: Carlo M. SCOPPOLA, Klaus-J. ENGEL

1	Course objectives	The goal of this course is to introduce the fundamental notions of calculus, linear algebra, and basic material of plane and solid geometry, and to apply analytic, algebraic, spatial and logical reasoning to solve analytic and geometric problems. This Module covers the fundamental concepts of Calculus and Linear Algebra and its roles in describing analytic and geometric settings. On successful completion of this module, the student should have profound knowledge of the basic techniques in Calculus and Linear Algebra; furthermore he will develop analytic and spatial sense, visualize and represent analytic problems and geometric figures, explore transformations of geometric figures, understand and apply geometric and analytic properties and relationships, synthesize analytic and geometric concepts into algebraic, functional, and problem-solving activities.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Basic set theory, sequences, series, limits and continuity, differential and integral calculus for real functions of one real variable. Vector spaces, systems of linear equations, matrices, linear mappings, canonical forms. Euclidean plane geometry, angles, radians, notion of geometric, place, properties of triangles, parallelograms, circles, symmetry and similarity, transformations in the plane, Cartesian

		coordinates and equations of simple geometric places, elements of trigonometry, elements of spatial Euclidean geometry, volumes. On successful completion of this module, the student should - have profound knowledge of the main analytic and algebraic techniques to manipulate numbers, polynomials, matrices and real functions; - have knowledge and understanding of the range of applications of those techniques to successfully solve problems in calculus, algebra and geometry, and of geometric relationships within the axiomatic structure of Euclidean geometry; - be able to understand and explain the main notions and results of calculus, the relation of geometry to algebra and trigonometry by using the Cartesian coordinate and to recognize geometric relationships in the world; - be able to understand and apply geometric and analytic properties and relationships; - demonstrate skill in mathematical reasoning by synthesizing analytic and geometric concepts into algebraic and ability to calculate solutions; - demonstrate capacity to read and understand other texts on related topics.
3	Prerequisites and learning activities	The student must know elementary facts of set theory, the basic notions of functions and geometry, and should be able to do numeric and symbolic calculations at high school level.
4	Teaching methods and language	Lectures, exercise classes, home work. Language: Italian Ref. Text books: Klaus Engel, Appunti del Corso di Analisi Matematica. http://univaq.it/~engel/ana1.pdf, M. Bramanti, C.D. Pagani, S. Salsa, *Matematica.* Zanichelli. M. Artin, *Algebra*, Boringhieri. Paola Favro e Andreana Zucco, *Appunti di Geometria Analitica.* Quaderni Didattici del Dipartimento di Matematica-Università di Torino. 2004.
5	Assessment methods and criteria	Written and oral exam.

Programme of "ESERCITAZIONI DI PREPARAZIONI CHIMICHE" "*BASIC PRACTICE IN CHEMISTRY*".

F0056, Compulsory
1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES" 1st Year, 1st and 2nd Semester

Number of ECTS credits: 9 (Workload: 225 hours, 1 credit = 25 hours)

Teachers: Massimiliano ASCHI – Nicoletta SPRETI

1	Course objectives	The goal of this course is to provide the students with a deep knowledge of stoichiometry and basic knowledge of the chemical practice in particular in laboratory. On successful completion of this module, the student should be able of solving any stoichiometric problem and should be able to perform basic laboratory operations.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Basic stoichiometry on pure species, mixtures and solutions. Chemical equilibrium between pure species. Chemical equilibrium in solution. Electrochemistry. Multiple equilibria. Practice in the chemical laboratory. On successful completion of this module the student should - be able to predict the structure of any molecule and the hybridization of the related atoms; - be able to provide the name of the most common chemical substances; - be able to use the basic instrumentation of chemical laboratory including: preparation of solutions, titration, measurement of pH, precipitation. - demonstrate skill in the solution of advanced stoichiometry problems; - demonstrate capacity to be critical and self-critical.
3	Prerequisites and learning activities	The student must know the basic notions of mathematics and, possibly, of elementary physics.
4	Teaching methods and language	Lectures and practical exercises in laboratory. Language: Italian and in English upon request Ref. Text books The student can select one of these books: • F. Cacace, M. Schiavello "Stechiometria" Libreria Universitaria • M. Bruschi *"Stechiometria e laboratorio di Chimica Generale"* Pearson Education Italia

5	Assessment methods and criteria	Written exam and oral discussion on the exercises in laboratory

Programme of "LABORATORIO DI FISICA GENERALE": *"LABORATORY OF GENERAL PHYSICS"*		
F0043, Compulsory **First cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES" 1st year , 2nd semester**		
Number of ECTS credits: 6 (Workload is 150 hours; 1 credit = 25 hours)		
Teacher: Patrizia FRANCIA		
1	Course objectives	The goal of this course is to introduce the students to basic laboratory practice on measuring physical quantities and to give hands-on experience with the physical laws. On the successful completion of this course the student should be able to set up an experiment, evaluate the results of measurements, distinguish between experimental uncertainties and mistakes in reading or recording information, optimize the measurement conditions and to interpret the experimental results using an appropriate statistical analysis.
2	Course content and Learning outcomes (Dublin descriptors)	The course includes experiments on mechanical properties of matter, the heat transfer, and the use of electric materials and circuits. Typically, there are six experiments that have to be done. A major topic regards the treatment of the experimental measurements and the error analysis. On the successful completion of this module, the student should: - acquire knowledge and understanding of the error analysis fundamentals. - apply knowledge and understanding of the error analysis to the experimental measurements. - demonstrate skills in collecting and analyzing data. - demonstrate capacity for communicating and representing quantitative information or results from the experiments.
3	Prerequisites and learning activities	Basic mathematics as well as differential and integral calculus is a necessary prerequisite of the course. The student should also have familiarity with basic physics.
4	Teaching methods and language	Lectures and practical laboratory activities. Language: Italian. Text book: J.R. Taylor "Introduzione all'analisi degli errori", Zanichelli
5	Assessment methods and criteria	Practical laboratory activities followed by oral examination.

Programme of "METODI COMPUTAZIONALI" *"COMPUTATIONAL METHODS"*		
F0167, Compulsory **1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 1st year , 2nd semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Isabella DAIDONE		
1	Course objectives and Learning outcomes	The main objective of the course is to provide the background in computational methods for solving simple chemical and physical problems and to familiarize students with a variety of numerical algorithms of benefit to chemists. On successful completion of this course the student is able to use a series of numerical algorithms, and a programming language, to solve simple scientific problems, that make a chemist computer literate.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the course include: Introduction to the computer Hardware/Software; The UNIX operating system; Filesystem; User interface; Shell and environmental variables; UNIX commands; Text editors; Graphing tools (Xmgrace). Numbers Binary representation of numbers; Floating point precision; Errors and stability. Coding basics (Fortran) Input/Output; Arrays; Matrices; Loops; Programming style; Programming tips; Testing your code; Understanding the problem; Debugging the code. Basic algorithms Numerical series; Evaluating polynomials; Interpolation of data using Lagrange polynomials;

		Root-finding methods (e.g. the bisection method); Application to a chemical problem: the pH of a solution. Differentiation and Integration Discretization schemes; Numerical Differentiation; Numerical Integration using Rectangles, the Trapezoidal Rule or the Simpson's Rule. Differential equations Differencing; The initial and boundary value problems; Euler and Runge-Kutta methods; Forward/backward differencing; Application to the solution of chemical kinetics equations; The Verlet algorithm; Application to the solution of Newton equations of motion; Energy conservation; Error analysis and stability; Energy conservation. On successful completion of this module, the student should - have profound knowledge and understanding of the basic algorithms to solve simple physical and chemical problems. - demonstrate ability to design an efficient approach to solving chemical and physical problems. - be able to assess the feasibility of computational solutions to complex problems. - understand and explain the meaning of a numerical solution. - be able to adapt the numerical solution to a problem to a different programming language.
3	Prerequisites and learning activities	Basic knowledge of mathematical analysis and algebra and of classical mechanics are required.
4	Teaching methods and language	Lectures, exercises and (computer) laboratory classes. Language: Italian; English upon request. Ref. text books: - S.E. Koonin and D.C. Meredith: "Computational Physics" - Ed. Addison-Wesley - W.H. Press, S.A. Teukolsky, W.T. Vetterling, B.P. Flannery: "Numerical Recipes - the Art of Scientific Computing" Ed. Cambridge Univ. Press
5	Assessment methods	Written and oral exam.

Programme of "CHIMICA ANALITICA I CON LABORATORIO " ***"ANALYTICAL CHEMISTRY I WITH LABORATORY"***		
F0283, Compulsory **1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 2nd year , 1st semester**		
Number of ECTS credits: 9 (workload is 225 hours; 1 credit = 25 hours)		
Teacher: Angelo Antonio D'ARCHIVIO		
1	Course objectives and Learning outcomes	The goal of this course is to introduce students to theory and applications of quantitative chemical analysis. The first part covers basic chemistry of classical volumetric analytical methods based on neutralisation and redox reactions. The second half of the course covers common instrumental techniques based on potentiometric and spectrophotometric methods and principles of chromatographic separations. These topics will be the subjects of hands-on activities of laboratories. On successful completion of this module, the student is expected to become familiar with the selected analytical methods, be aware of potential applications to real-world systems, to gain independent laboratory skills in the experimental techniques and interpretation of analytical data, to understand the principles behind the construction of common analytical instrumentation.
2	Course content and Learning outcomes (Dublin Descriptors)	Topics of the module include: Basic terms and parameters of the analytical process: Aims of analytical chemistry. General steps in a chemical analysis. Errors in chemical analysis. Aqueous solution chemistry: Review of chemical equilibrium and equilibrium constants. Systematic treatment of acid-base equilibria. Overview of redox reactions and electrochemistry Chemical analytical techniques and their applications: Neutralisation titrations in aqueous solutions. Volumetric methods based on redox reactions. Potentiometric methods: Potentiometric electrochemical cells. The Nernst equation. Reference and indicator electrodes. Membrane electrodes. Quantitative applications. Spectroscopic methods: Overview of spectroscopy. Spectroscopy based on absorption. Molecular UV/vis absorption. Photoluminescence and chemiluminescense. Atomic absorption

		and emission spectroscopy. Introduction to chromatographic separations: Principles of chromatography. Qualitative description of retention phenomenon and band broadening. Principles of gas-chromatography and high-performance liquid-chromatography. On successful completion of this module, the student should - have profound knowledge of the selected analytical methods, - have knowledge and understanding of physical and chemical basis of volumetry and instrumental analytical chemistry, - understand and explain with scientific language the principles of the analytical procedures and instruments and their optimal use to characterize matter and systems - understand the fundamentals of the analytical techniques and be aware of their potential applications to real-world systems - demonstrate skill in proposing possible strategies for quantitative analysis and sample treatment and ability to organise and conduct analytical experiments - demonstrate capacity for reading and understanding analytical procedures.
3	Prerequisites and learning activities	The student must know the basic notions of General Chemistry and Stoichiometry
4	Teaching methods and language	Lectures and laboratory experiments Language: Italian Ref. Text books D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch: Fondamenti di Chimica Analitica, EdiSes, Napoli 2010
5	Assessment methods	Written and oral exam.

Programme of "CHIMICA ANALITICA II CON LABORATORIO "
"ANALYTICAL CHEMISTRY II WITH LABORATORY"

F0298, Compulsory for curriculum in Chemistry
1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 2nd year , 2nd semester

Number of ECTS credits: 9 (workload is 225 hours; 1 credit = 25 hours)

Teachers: Angelo Antonio D'ARCHIVIO, Fabrizio RUGGIERI

1	Course objectives and Learning outcomes	The goal of this course is to integrate the programme of analytical chemistry provided by the course "Analytical Chemistry I with topics of complementary chemical and instrumental methodologies. The first part covers basic chemistry of classical volumetric methods based on precipitation and complex-formation, principles of gravimetry and systematic treatment of multiple-equilibria in aqueous solution. The second half of the course provides an overview of instrumental techniques based on chromatography and electrophoresis, electrogravimetry, coulometry, polarography and voltammetry The topics covered in lecture will be the subjects of hands-on activities of laboratories. On successful completion of this module, the student is expected to become familiar with the selected analytical methods, be aware of potential applications to real-world systems, be able to recognize sources of errors, to interpret and critically evaluate analytical results, and improve their abilities in laboratory work.
2	Course content and Learning outcomes (Dublin Descriptors)	Topics of the module include: Chemical equilibria: Precipitation and complexation equilibria. Systematic treatment of multiple equilibria. Chemical analytical techniques and their applications: Volumetric methods based on precipitation and complex-formation reactions. Gravimetric methods. Introduction to electrolytic methods: Electrolytic cells and quantitative aspects of electrolysis. Kinetic and concentration polarisation. Electroanalytical methods: Electrogravimetry. Controlled potential coulometry and coulometric titrations. Hydrodynamic voltammetry. Polarography. Amperometric detectors. Pulse methods. Separation methods: General theory of chromatography. Optimisation of chromatographic separations. Gas-chromatography. High-performance liquid chromatography. Ion-exchange, size-exclusion and supercritical fluid chromatography. Capillary electrophoresis. On successful completion of this module, the student should - have profound knowledge of the selected analytical methods,

		- have knowledge and understanding of physical and chemical basis of volumetric and instrumental analytical methods , - understand and explain with scientific language the optimal use of the available analytical techniques to characterize matter and systems - understand the principles of the analytical techniques and be aware of their potential applications to real-world systems - demonstrate skill in proposing possible strategies for quantitative analysis and sample treatment and ability to organise and conduct analytical experiments - demonstrate capacity for reading and understanding analytical procedures .
3	Prerequisites and learning activities	The student must know the notions of Analytical Chemistry provided by the course of Analytical Chemistry I with Laboratory
4	Teaching methods and language	Lectures and laboratory experiments Language: Italian Ref. Text books D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch: Fondamenti di Chimica Analitica, EdiSes, Napoli 2010 Lectures. Language: Italian
5	Assessment methods	Oral exam.

Programme of "CHIMICA FISICA I CON LABORATORIO": "PHYSICAL CHEMISTRY I WITH LABORATORY"		
F0303, Compulsory 1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 2^{nd} year , 2^{nd} semester		
Number of ECTS credits: 9 (workload is 225 hours; 1 credit = 25 hours)		
Teacher: Fabio RAMONDO		
1	Course objectives	The student should be able to use chemical thermodynamics and chemical kinetics to predict the stability of matter (gases, liquids, solids and solutions) and its transformations (phase equilibria and chemical reactions). Experimental physical chemistry methods are emphasized through laboratory experiences.
2	Course content and Learning outcomes (Dublin Descriptors)	Topics of the module include: Gases and thermodynamic equilibrium: Introduction to thermodynamic equilibrium, equations of state, gases and liquids, intermolecular forces. First Law of thermodynamics: Heat, work, and thermodynamic energy. The First Law and chemical reactions. Entropy and the Second Law of thermodynamics: Entropy and spontaneity. Calculation and measurement of entropy changes. Free energy and spontaneity: Gibbs and Helmholtz free energies and the natural direction of processes. Phase behavior of pure substances: Solids, liquids and gases. Phase transformations. Thermodynamics of mixtures: Ideal and nonideal liquid-liquid and solid-liquid solutions. Chemical equilibrium: Thermodynamic determinations of the equilibrium constant. Dynamics and chemical kinetics: Kinetic theory of gases. Reaction rate laws, reaction mechanisms, and theories of reaction rate constants. After a successful course completion, the student should: - have knowledge of the fundamental laws of thermodynamics and capacity to use these laws to analyze physical and chemical processes; -be able to explain if and because a process can occur spontaneously; - demonstrate capacity to locate thermodynamic data of common chemical compounds and how to use this data; - demonstrate capacity in the use thermodynamic data to solve for equilibrium concentrations as a function of Temperature and Pressure; - be able to interpret phase diagrams for both pure substances and mixtures; - have knowledge of the meaning of ideal gas and solution and real gases and solutions and how to quantitative treat them; - have knowledge of the methods to quantitatively treat the rates of chemical reactions and how thermodynamic and kinetic factors can be controlled to maximize yield and minimize energy costs; - demonstrate capacity to use the common software to solve analytical and numerical problems

3	Prerequisites and learning activities	The student must know the basic notions of General Chemistry and General Physics and basic notions of differential and integral calculus.
4	Teaching methods and language	Lectures, numerical exercises and practical training. Language: Italian/English Ref. Text books P. W. Atkins, *Physical Chemistry*, Zanichelli Ed. 2010 D. A. Mc Quarrie, J. D. Simon *Physical Chemistry: a Molecular Approach*, Zanichelli Ed. 2010
5	Assessment methods and criteria	Oral exam

Programme of "CHIMICA ORGANICA I CON LABORATORIO" ***"ORGANIC CHEMISTRY I WITH LABORATORY"*****:**		
F0288, Compulsory **1st Cycle Degree in "CHEMICAL CHEMISTRY AND MATERIALS SCIENCES" 2nd year , 1st semester**		
Number of ECTS credits: 9 (workload 225 hours; 1 credit = 25 hours)		
Teachers: Francesco DE ANGELIS; Giorgio CERICHELLI; Nicoletta SPRETI		
1	Course objectives	The objective of the course relies on providing the student with motivations, knowledge of the subject fundamentals, definitions and nomenclature, basic competences on the organic molecules, their structures, spacial configurations and reactivity. Focus is directed onto the principal reactions of aliphatic hydrocarbons and their functional derivatives. The theoretical lessons are flanked by laboratory experiences, focused at giving the student a first level of confidence with the experimental work in an organic laboratory. On successful completion of the course, the student should manage with confidence, both at the theoretical and experimental level, the fundamental as well as practical aspects of the subject, and also have a deeper understanding of the basic reactions of organic chemistry, and of organic stereochemistry.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the course include: Alcanes and cycloalcanes. Structure, isomerism, conventional and IUPAC nomenclature. Conformations. Steric tension. *Cis-trans* isomerism in substituted cycloalcanes. Physical properties. Sources. Principal reactions. Stereochemistry and chirality. Types of isomerisms. Chirality. Absolute configuration, nomenclature (*R,S* system). Fischer projections. Properties of stereoisomers. Optical activity, polarimeter. Chemical and enzymatic resolution of the racemic mixtures. Stereogenic atoms other than carbon. Chiral molecules without stereogenic atoms. Stereospecific and stereoselective reactions. Alkenes. Structure, nomenclature, physical properties. Electrophilic additions of acids, water under acid catalysis. Carbocations. Addition of halogens, oxymercuration reaction, hydroboration/oxidation. Oxidation reactions. Catalytic hydrogenation: thermodynamic stability of alkenes. Conjugated dienes: stability, electrophilic additions. Addition of halogen acid: kinetic and thermodynamic control. Alkynes. Structure, nomenclature. Acidity. Stereoselective hydrogenation to alkenes. Electrophilic additions. Alkyl halides. Structure, nomenclature. Halogenation of alkanes: mechanism, regioselectivity. Hammond postulate. Radical addition of HBr to alkenes. Aliphatic nucleophilic substitutions and β-eliminations. Nucleophilic substitution of alkyl halides. Mechanisms, experimental evidence. Classification of solvents. β-elimination reactions. Mechanisms, experimental evidence. Competition between substitution and elimination. Alcohols and Thiols. Structure, nomenclature, physical properties. Acid/base properties. The reaction of alcohols with metal sodium, converting Alcohols in alkyl halides, dehydration, oxidation. Diols and pinacol transposition. Oxidation of thiols to disulfides. Ethers and sulfides. Structure, nomenclature. Physical properties. Using oxyether as solvent: purification and precautions. Epoxides. Structure (Ring strain). Opening promoted by acids or bases. Organic Chemistry Laboratory. Introduction to organic laboratory techniques. Solvent extraction. Crystallization. Distillation. Thin layer chromatography. Column chromatography. Practical experiments are performed on solvent extraction, separation and purification of some organic compounds.

		On successful completion of this module, the student should - have profound knowledge of the subject fundamentals; - have knowledge and understanding of the main organic reactions, on stereochemistry, on practical organic chemistry; - understand and explain fundamentals as well as structural and basic reactivity characteristics of organic molecules, using the appropriate, technical language; - understand the fundamental concepts of organic chemistry, and its connections with general chemistry, thermodynamics and kinetics; - demonstrate skill in managing organic structures and reactions and ability to conceive and implement organic experiments; - demonstrate capacity for reading and understanding other texts on related topics.
3	Prerequisites and learning activities	The student must know the fundamental notions of General Chemistry and of General Chemical Laboratory.
4	Teaching methods and language	Lectures, team work in the laboratory practice, exercises, homework, reports, tests. Language: Italian and English. Ref. Text books - Brown, Foote, Iverson, Anslyn – Organic Chemistry 4 ed.; - M. D'Ischia, La Chimica Organica in Laboratorio, PICCIN Ed.
5	Assessment methods and criteria	Written and oral exam.

Programme of "CHIMICA ORGANICA II CON LABORATORIO"
"ORGANIC CHEMISTRY II AND LABORATORY "

F0293, Compulsory
First cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 2nd year, 2nd semester

Number of ECTS credits: 9 (workload is 225 hours; 1 credit = 25 hours)

Teacher: Antonio ARCADi

1	Course objectives	The second semester of a two semester organic chemistry sequence continues the systematic study of the theories and principles of organic chemistry. Exercises and laboratory experiments reinforce the basic principles discussed in lecture as well as provide practical examples. The laboratory must be satisfactorily completed to receive a passing grade for the course.
2	Course content and Learning outcomes (Dublin descriptors)	Topics include: • Nomenclature, structure, properties, reactions, and mechanisms of aromatics, aldehydes, ketones, carboxylic acids and derivatives and amines. • Introduction to carbohydrates, lipids, peptides and nucleic acids. • Laboratory methods applied to the synthesis, separation, purification and identification of organic compounds. On successful completion of this module, the student should - understand organic concepts as needed to pursue further study in chemistry and materials science. - be aware of potential applications of basic concepts of Organic chemistry in other fields; - demonstrate skill in problems solving on related topics and in organic chemistry laboratory techniques as reflux, distillation, extraction, filtration, re-crystallization and chromatography; - demonstrate capacity of interpreting the results of experiments and preparing laboratory reports with proper scientific writing style.
3	Prerequisites and learning activities	The student must know the basic notions of Organic Chemistry I with Laboratory.
4	Teaching methods and language	Lectures, exercises and laboratory experiments. Language: italian Ref. Text books Organic Chemistry, 7th Edition, International Edition- W. H. Brown, B. L. Iverson, E. V. Ansylin, C. S. Foote, Wadsworth Cengale Learning, 2012 Italian translation: Chimica Organica, EDISES. 2012
5	Assessment methods and criteria	Written and oral exam

Programme of "CHIMICA DELLE MACROMOLECOLE" *"MACROMOLECULAR CHEMISTRY"*		
F0092, Compulsory **1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES" 2nd year , 2st semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Pier Paolo PONTI		
1	Course objectives	The study of Polymer Chemistry allows the student to put in relation the observed properties of polymeric materials with the structure of polymers. Aim of the teaching course is to enable the student, on the basis of structural knowledge, to design new materials, to predict the properties and modulate them with a view at specific uses. On successful completion of this module the student will have acquired the ability to deeply understand and exploit the relation between structure of polymeric materials and the properties observed.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Synthesis of polymers and copolymers by chain growth polymerization and step growth polymerization. Order and regularity in structure. Molecular weight of polymers. Structure-property relations. Mechanical properties of polymers. Chemical properties. Polymers of industrial interest, production, uses. On successful completion of this module, the student should -have profound knowledge of polymer synthesis; -have knowledge and understanding of structure-property relations in polymeric materials; -understand the fundamental techniques of polymer characterization; -demonstrate skill in fronting chemical aspects of polymerizations; -demonstrate capacity for reading and understanding the chemical literature on polymers.
3	Prerequisites and learning activities	The teaching course uses knowledge acquired in courses in Physics and General, Organic, Physical Chemistry.
4	Teaching methods and language	Lectures. Language: Italian Ref. Text books Allcock, H.R.; Lampe, F.W.:Contemporary Polymer Chemistry,Prentice-Hall; Cowie, J.M.G.: Polymers. Chemistry and Physics of Modern Materials, Blackie Academic.
5	Assessment methods and criteria	Oral exam.

Programme of "FISICA DELLA MATERIA" *"PHYSICS OF MATTER"*		
F0091, Compulsory **1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 2nd year , 1st semester**		
Number of ECTS credits and workload depend on the selected Track . **Track "CHEMISTRY": N. credits 6 (workload = 150 hours; 1 credit = 25 hours)** **Track "MATERIALS SCIENCES": N. credits 9 (workload = 225 hours; 1 credit = 25 hours)**		
Teacher: Luca LOZZI		
1	Course objectives and Learning outcomes	The goal of this course is to provide the fundamental knowledge on quantum physics. The classical mechanics crisis and the evolution of the quantum mechanics up to the hydrogen atom solution will be shown. On successful completion of this module, the student should understand: - the main failures of the classic mechanics at the atomic size - the most important experiments that allowed the evolution of modern physics - the fundamental concepts of quantum mechanics - the main experimental techniques to investigate the atomic structure of atoms
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: The particle-like properties of electromagnetic waves: Black-body radiation, Rayleigh-Jeans law, the Planck theory, the photoelectric effect, the Compton effect The structure of atoms: The Rutherford's model, the Bohr's theory, quantisation of the states, correspondence principle, the Franck-Hertz experiment Wave-like properties of particles: The de Broglie wavelength, wave packets, the Heisenberg principle of uncertainty, wave functions and probability amplitude, dual nature of particles and waves

		The Schroedinger equation: properties of the Schroedinger equation, eigenfunctions and eigenvalues, operators in quantum mechanics, examples of the Schroedinger equations The hydrogen atom: The Schroedinger equation for one-electron atoms, solutions of the Schroedinger equation for one-electron atoms, the angular momentum operators, the Stern-Gerlach experiment and the electron spin. Laboratory: grating and prism, Rydberg constant, Stefan-Boltzmann law, q/m ratio, Planck constant, Franck-Hertz experiment. On successful completion of this module, the student should - have profound knowledge of modern physics, - have knowledge and understanding of evolution from classical physics to quantum mechanics, - understand and explain the particle-wave dual nature of light and particles - understand the fundamental concepts of quantum physics, - demonstrate skill in mathematical notation and language of modern physics and ability to manage wave mechanics - to demonstrate capacity for reading and understand other texts on related topics.
3	Prerequisites and learning activities	The student must have a good background of general physics, as mechanics, electromagnetism, optics, and of analysis (functions, derivatives, integrals)
4	Teaching methods and language	Lectures and exercises. Language: Italian / English (if non-native Italian students are present) Ref. Text book Kenneth Krane, *Modern Physics,* John Wiley & Sons
5	Assessment methods	Written and oral exam.

Programme of "SCIENZA DEI MATERIALI" "*MATERIALS SCIENCE*"		
F0078, Compulsory 1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 2nd year, 1st semester		
Number of ECTS credits and workload depend on the selected Track . Track "CHEMISTRY": N. credits 6 (workload = 150 hours; 1 credit = 25 hours) Track "MATERIALS SCIENCES": N. credits 9 (workload = 225 hours; 1 credit = 25 hours)		
Teacher: Giuliana TAGLIERI		
1	Course objectives and Learning outcomes	The goal of the course is developed to provide an understanding of the relationship between structure, processing and properties of materials. As concerns the "Applied Chemistry" section, the course is intended to be an introduction to water treatment technologies and to preliminary concepts on inorganic bindings. On successful completion of this module, the student should develop an understanding of how the structure of a material, from the nano- to the macro-scale, governs its behavior and they are introduced to the techniques and methodologies that characterize that structure; the control of that structure through processing is also a key topic; in addition, the role of the engineer in designing with and selection of materials is outlined.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the two modules include: Atomic Arrangement and Defects: The atomic structure and electronic structure; atomic bonding. Short-range order and long-range order; unit cells; allotropic or polymorphic transformations; solid crystals; X-ray diffraction. Point defects. Surface defects (material surface, grain boundaries, twin boundaries). Dislocations. Atomic movement in materials: Diffusion mechanism; activation Energy for diffusion; Fick's laws; diffusion and materials processing (grain growth, sintering, diffusion bonding). Mechanical testing and Properties: The tensile test, stress-strain curve, properties obtained from the tensile test. The bend test for brittle materials. The hardness tests (Brinell, Rockwell, Vickers, Knoop tests). The impact test; ductile-fragile transition. The importance of fracture mechanics. Fracture toughness. The fatigue test: results and application of fatigue testing. The creep test. Solid Solution and Phase Equilibrium: Phases and the unary phase diagram; phase rule. Solubility and solutions: unlimited solubility, limited solubility, conditions for unlimited solubility. Solid solution strengthening. Isomorphous phase diagrams: liquidus and solidus temperatures, composition of each phase, lever law. Solidification of a solid solution alloy;

		non-equilibrium solidification and segregation. Phase diagrams containing three-phase reactions. The eutectic phase diagram. Eutectic, hypoeutectic and hypereutectic alloys. Strength of eutectic alloys. Non-equilibrium freezing in the eutectic system. Dispersion strengthening by phase transformation and heat treatments: Nucleation and growth in solid-state reactions: nucleation, growth and kinetics. Alloy strengthened by exceeding the solubility limit, coherent precipitates. Age hardening or precipitation hardening (solid solution, quench, age). Effect of aging temperature and time. Requirements for age hardening. Fe-Fe3C diagram and the eutectoid reaction: solid solutions, compounds, the eutectoid reaction, perlite, primary constituents. Controlling the eutectoid reaction, time-temperature-transformation (TTT) diagram. Martensitic reaction and tempering: martensite phase in steels, properties of steel martensite, tempering of martensite, martensite in other systems. Continuous cooling transformation (CCT) diagrams Metals: Ferrous alloys: Designations for steels. Simple heat treatments (annealing, normalizing, quench and temper heat treatments, isothermal heat treatment); surface treatments. Effect of alloying elements. Special steels. Phase transformations in cast iron; the eutectic and eutectoid reaction in cast irons. Nonferrous alloys: Aluminum alloys; general properties of aluminum, designation, casting alloys, advanced aluminum alloys. Magnesium alloys; structure and properties. Copper alloys; solid solution strengthened alloys. Nickel and cobalt: nickel and Monel; precipitation hardening. Processing of metals: Casting processes; cold working; strain hardening; the three stages of annealing; hot working; metals joining; metallurgy of powers. Ceramic materials: Structures of materials. Imperfections in crystalline lattice of ceramic materials. The structure of ceramic glasses; silicate glasses; modified silicate glasses. Processing and applications of ceramic glasses. Processing and applications of clay products. Processing and applications of advanced ceramics (pressing and sintering). Refractories Polymers: Classification of polymers, representative structures. Polymerization. Temperature glass transition. Deformation and failure of thermoplastic polymers. Elastomers. Thermosetting polymers. Forming of polymers. Physical properties of Materials: Electrical behavior (band theory, conductivity in metals and in semiconductors, insulators and dielectric properties). Magnetic properties. Thermal properties of materials (heat capacity and specific heat, thermal expansion, thermal conductivity). On successful completion of this module, the student should - have a preliminary understanding of the chemical, electrical and mechanical properties of materials, and relate that to their microstructure, in a wide range of different systems, including metals and alloys, polymers, engineering ceramics, and semiconductors; knowledge and understanding of the basis of processing, production and selection of materials; - have a broad but detailed appreciation of materials and their properties; - have a preliminary understanding of the chemical, electrical and mechanical properties of materials, and relate that to their microstructure, in a wide range of different systems, including metals and alloys, polymers, engineering ceramics, and semiconductors; - have a knowledge and understanding of the basis of processing, production and selection of materials.
3	Prerequisites and learning activities	The student must know the basic notions of Mathematics, Chemistry and Fundamentals of Physics.
4	Teaching methods and language	Lectures and exercises. Language: Italian / English Ref. Text books D.R. Askeland, *The Science & Engineering of Materials*, Ed. PWS-Kent Publishing Company, Boston S.D. Faust, O.M. Aly, *Chemistry of Water Treatment,* CRC Press Italian translation: Callister, *Scienza e Ingegneria dei Materiali*, Edises
5	Assessment methods and criteria	Written and oral exam.

Programme of "BIOCHIMICA" ***"BIOCHEMISTRY"***
F0093, Compulsory **First cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES" 3rd year, 1st semester**
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)

Teacher: Gabriele D'ANDREA		
1	Course objectives	The goal of this course is to provide the structural, functional, and metabolic bases of the main biomolecules, underlining the pivotal role of enzymes and their cofactors as well as the crucial play carried out by the metabolic regulation. On successful completion of this course the student should be aware of the biomolecular basis, metabolic sequences, and metabolic regulation concerning the main biochemical processes. Moreover the student should understand the foundations of the enzyme kinetics and bioenergetics.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the course include: Foundations of Biochemistry: The molecular logic of life. Cells. Biomolecules. Water. Biomolecule structure/function and catalysis. Amino acids. Peptides. Proteins. Enzymes. Carbohydrate. Nucleotides and nucleic Acid. Lipids. Biological membranes and transport. Biosignaling. Bioenergetics and Metabolism: Principles of bioenergetics. Glycolysis and catabolism of hexoses. Gluconeogenesis. Glycogen metabolism. The citrate cycle. Oxidation of fatty acids. Amino acid oxidation and urea production. Oxidative phosphorylation and photophosphorylation. Carbohydrate biosynthesis. Lipid biosynthesis. Biosynthesis of amino acids, nucleotides and related biomolecules. Integration of hormonal regulation of mammals metabolism. Information pathways: Genes and chromosomes. DNA metabolism. RNA metabolism. Protein metabolism. Recombinant DNA technology. On successful completion of this course, the student should - have acquired deep knowledge of the structure and function of the main biomolecules; - have knowledge and understanding of the basic metabolic pathways and their regulation; - make judgments about the type of enzymatic inhibitions; - understand and explain the foundations of bioenergetics; - have knowledge and understanding the main genetics information pathways; - demonstrate capacity for reading and understand other texts/articles on related topics.
3	Prerequisites and learning activities	The student must know the basic notions connected with the previous exams such as General & Organic Chemistry.
4	Teaching methods and language	Lectures based on Power Point presentations. Language: Italian Ref. Text book Introduzione alla Biochimica di Lehninger 4e di D.L. Nelson e M.M. Cox, Zanichelli, Bologna, 2010.
5	Assessment methods and criteria	Written and oral exam.

Programme of "METODI DI INDAGINE STRUTTURALE" *"METHODS OF MOLECULAR STRUCTURE INVESTIGATION "*		
F0094, Compulsory **1st Cycle in Degree "CHEMISTRY AND MATERIALS SCIENCES", 3rd year , 1st semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teachers: Giorgio CERICHELLI – Francesco DE ANGELIS		
1	Course objectives	The objective of the course relies on providing the student with motivations and knowledge of the basic principles of the subjects of the module (their fundamentals, definitions and nomenclature), and their use for the structural determination of organic molecules. The techniques which are treated to some extent within the module are the following: UV-Vis. Spectroscopy, Infrared Spectroscopy (IR), calorimetry, fluorescence, Optical Rotatory Dispersion (ORD)/Circular Dichroism (CD), NMR spectroscopy, EPR and Mass Spectrometry (MS). On successful completion of the module, the student should manage with confidence fundamental as well as practical aspects of the subjects, and also be able to understand and interpret the graphics and spectra relevant to the taught spectroscopies.
2	Course content and Learning outcomes (Dublin descriptors)	Topics include: UV-Vis. Spectroscopy: instruments, spectra, laws, common use; NMR spectroscopy: continuous wave and FT instruments ,1H simple spectra interpretation, decoupling, solvent soppression;

		Calorimetry: basic kinds of instruments and related techniques; Fluorescence: basic principle, instruments, UV-Vis. and X fluorescence; EPR: basic principle, instruments, simple spectra analysis. Infrared Spectroscopy (IR): continuous wave IR spectrometer; Fourier transform IR spectroscopy; absorbance frequencies of functional groups; the IR spectrum; use of IR tables. Optical Rotatory Dispersion (ORD)/Circular Dichroism (CD): chirality and circularly polarised light; definitions; ORD and CD spectra; Cotton effect; chromophore types; molecular chiral environment; empirical rules; CD of biopolymers. Mass Spectrometry (MS): principles of MS; "block description" of a MS instrument; Electron Ionisation (EI) and Chemical Ionisation (CI) sources; sector analysers; detectors; ionization efficiency; motion equations; QET; metastable ions; EI spectra (simple molecules); ion types; resolving power; accurate mass; isotopic patterns. On successful completion of this module, the student should - have profound knowledge of the subjects fundamentals; - have knowledge and understanding of the taught techniques, and their usage for the structural elucidation of organic molecules; - understand and explain fundamentals as well as use and application boundaries of the techniques of interest, by using the appropriate, technical language; - understand the fundamental concepts of the taught techniques, and their connections with organic chemistry and with the other structural elucidation techniques; - demonstrate skill in managing the spectra obtained by the techniques of interest, and in proposing further experiments in order to get more structural information; - demonstrate capacity for reading and understanding other texts on related topics.
3	Prerequisites and learning activities	The student must know the fundamental notions of General Physics, General Chemistry, Organic Chemistry and Organic Chemistry Laboratory.
4	Teaching methods and language	Lectures, ppt presentations, exercises, demonstrations on the instruments; homework, reports, tests. Language: Italian; English on demand. Ref. Text books - R. M. Silverstein, "Identificazione spettroscopica di composti organici". Ambrosiana Ed. - A. E. Derome, "Modern NMR techniques for chemistry research". Pergamon press. - D.H. Williams, I Fleming, "Spectroscopic Methods in Organic Chemistry". McGraw-Hill Co., London.
5	Assessment methods and criteria	Oral exam

Programme of "CHIMICA DELL'AMBIENTE" ***"ENVIRONMENTAL CHEMISTRY"***		
F0100, Compulsory **1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 3rd year , 1st semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Fabrizio RUGGIERI		
1	Course objectives	The aim of the course in environmental chemistry is to give students a thorough understanding of the natural and anthropogenic process that occur on nature. Knowledge of these processes is necessary to understand the balance in ecosystems, and to manage the risks associated with anthropogenic activities.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: General information on toxic organic molecules (pesticides, dioxins, dibenzofurans, polychlorinated biphenyls, polycyclic aromatic hydrocarbons), indices of toxicity, biodegradation of chlorinated pesticides, dioxins and PCBs in the environment. Water cycle, Aquatic systems and carbonate-bicarbonate equilibrium, degradation of silicates and pyrite. Phosphates, dissolved oxygen, pH and pE in environmental systems. Solubility of aluminum and iron in aquatic systems. Construction and interpretation of the pH and pE diagrams. Anaerobic decomposition of organic matter. Potable water, removal of colloids systems, disinfection systems and wastewater treatment. Use of photocatalysts in advanced oxidation systems. Nitrogen compounds and nitrogen cycle. Biogeochemical cycles, colloidal particles and clay minerals. Role of sediments in the processes of adsorption, cation exchange capacity, adsorption isotherms. Heavy metals in the environment

		(Mercury, Lead, Cadmium, Arsenic, Chromium), natural and anthropogenic sources, speciation of metals in different environmental compartments. Treatment and disposal of municipal waste. Disposal of toxic waste. Techniques for remediation of contaminated soils. On successful completion of this module the student should - have profound knowledge of chemical process in the environment; - have knowledge and understanding human activity on the environment and related changes; - be able to explain the natural and anthropogenic chemical process in environment - demonstrate skill in evaluation of environmental problems and ability to explain - demonstrate capacity for reading and understand other texts on related topics. - be able to apply the acquired knowledge to concrete cases as occurring in the professional life; - demonstrate concern to environmental issues; - be able to work in team - demonstrate capacity to be critical and self-critical
3	Prerequisites and learning activities	The student must know the basic notion of Inorganic and Organic Chemistry.
4	Teaching methods and language	Lectures. Language: Italian Ref. Text books Colin Baird, Michael Cann "Chimica Ambientale", Zanichelli Editore Stanley E. Manahan *"Chimica dell'ambiente",* Casa Editrice Piccin,
5	Assessment methods and criteria	Oral exam

Programme of "CHIMICA FISICA II CON LABORATORIO": *"PHYSICAL CHEMISTRY II WITH LABORATORY"*

F0308, Compulsory for curriculum in Chemistry
1st Cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES" , 3rd year , 1st semester:

Number of ECTS credits: 9 (workload is 225 hours; 1 credit =25 hours)

Teacher: Fabio RAMONDO

1	Course objectives	This course concentrates on learning to use 20th and 21st century developments in chemical theory to model and understand reactivity and structure. Starting from microscopic level, the results of quantum mechanics will be used to describe molecular structure. The theoretical results will be compared to evidence from measurements of molecular spectroscopy and physical properties. Experimental physical chemistry methods are emphasized through laboratory experiences.
2	Course content and Learning outcomes (Dublin Descriptors)	Topics of the module include: An introduction to quantum mechanics and its application to simple problems for which classical mechanics fails. Particle in a box, harmonic oscillator, rigid rotor, the hydrogen atom, approximate treatments of atoms and molecules, and the theoretical basis for molecular and atomic spectroscopy. After a successful course completion, the student should: - have knowledge and understanding of theoretical models of atoms, chemical bonding, and atomic and molecular spectroscopy grounded in the fundamentals of quantum theory; - be able to apply the concepts, methods and techniques of quantum chemistry to simple chemical systems and make predictions for these systems; - understand how derive molecular structures from molecular spectroscopy.
3	Prerequisites and learning activities	The student must know the basic notions of General Chemistry, General Physics and Thermodynamics along with basic notions of differential and integral calculus.
4	Teaching methods and language	Lectures, numerical exercises and practical training. Language: Italian/English Ref. Text books P. W. Atkins, Physical Chemistry, Zanichelli Ed. 2010 D. A. Mc Quarrie, J. D. Simon Physical Chemistry: a Molecular Approach, Zanichelli Ed. 2010
5	Assessment methods and criteria	Oral exam

Programme of "CHIMICA FARMACEUTICA" "*MEDICINAL CHEMISTRY*"		
F0096, Compulsory for curriculum in Chemistry **1st cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 3rd year, 1st semester**		
Number of ECTS credits: 6 (workload is 150 hours; 1 credit = 25 hours)		
Teacher: Antonio COLUCCIA		
1	Course objectives	The goal of this course is to provide the knowhow for the design of new drugs. Starting with the identification of a validated target, the analysis of the chemical structures and the evaluation of the pharmacological activity.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: The definitions of the drugs and target and a brief overview of the physiology and pharmacology. The study of the already known drugs, in terms of: chemical synthesis, structure activity relationships and biological activity is the starting point for the studied of new drugs. New methodologies ion drug discovery. On successful completion of this module, the student should - have profound knowledge of general rules that make a chemical compound a safe drug; - have knowledge and understanding of structure activity relationships of a drugs family; - understand and explain how to design and synthesized a drug; - understand why such chemical moiety are better than other; - demonstrate skill to rationalize the design of a drug and ability to suggest the synthesis; - demonstrate capacity for reading and understand other texts on related topics.
3	Prerequisites and learning activities	The student must know organic chemistry and biology/biochemistry
4	Teaching methods and language	Lectures were carried out in Italian with the support of PowerPoint presentations. Focus on the state of the art for some drug family was achieved by peer reviewed article Language: Italian / English Ref. Text books: G. Grieco: *Farmacocinetica e farmacodinamica su basi chimico fisiche*. Loghia Ed. A. David: *Principi di Chimica Farmaceutica* 6° Ed. Piccin.
5	Assessment methods and criteria	Oral exam

Programme of: "FISICA DELLO STATO SOLIDO CON LABORATORIO" "*SOLID STATE PHYSICS WITH LABORATORY*"		
F0189, Compulsory for curriculum in Materials Science **1st cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 3rd year , 2nd semester**		
Number of ECTS credits: 9 (workload is 225 hours; 1 credit = 25 hours)		
Teacher: Franco D'ORAZIO		
1	Course objectives	The goal of this course is to provide the elements of solid state physics, i.e. of the basic understanding of the thermal, electrical, optical and magnetic properties of condensed matter. In addition, the laboratory part supplies some skills for better comprehension of experimental solid state physics. On successful completion of this module, the student should understand the basic properties of metals, semiconductors, and insulators. In particular, the student will become familiar with the electronic states and with the vibrational dynamics of atoms and ions in solids.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: Theoretical part: Crystal structures, the crystal lattice and the reciprocal lattice; X-ray diffraction; lattice vibrations and thermal properties of insulating materials; electronic properties of materials; magnetic properties, dielectric properties and optical properties; superconductivity. Laboratory part: methods of data acquisition and processing; measurement of electrical and thermo-electrical properties of solids; measurement of optical properties; film deposition; measurement of magnetization and magnetic susceptibility of solids. On successful completion of this module, the student should - have profound knowledge of the most important properties of solids - have knowledge and understanding of the techniques appropriate for the characterization of such properties, - understand the basic concepts of solids structure and energy band formation

		- understand and explain the methods of data acquisition and processing - demonstrate skill in performing simple characterization experiments and ability to write a brief experiment report, - demonstrate capacity for reading and understanding other texts on related topics.
3	Prerequisites and learning activities	The student must know the basic concepts of quantum physics and structure of matter such as those learnt in the module "Fisica della Materia".
4	Teaching methods and language	Lectures, exercises, computer data acquisition and processing, lab experiments, experiment reports. Language: Italian/English Ref. Text books: *C. Kittel: Introduction to Solid State Physics* - John Wiley & Sons. R.M. Rose, L.A. Shepard, J. Wulff: *Struttura e proprietà dei materiali: proprietà elettroniche* (4° volume) - Casa Editrice Ambrosiana.
5	Assessment methods and criteria	Experiment reports and oral exam.

Programme of "FISICA DEI SEMICONDUTTORI E DISPOSITIVI CON LABORATORIO"
"PHYSICS OF SEMICONDUCTORS AND DEVICES AND LABORATORY"

F0188, Compulsory for curriculum in Materials Science
1st cycle Degree in "CHEMISTRY AND MATERIALS SCIENCES", 3rd year , 2nd semester

Number of ECTS credits: 9 (workload is 225 hours; 1 credit = 25 hours)

Teachers: Sandro SANTUCCI - Luca LOZZI

1	Course objectives	The aim of this course is to introduce the student to the fundamentals of Solid State Electronics and to apply these principles to the understanding of the physical, electrical, and optical properties of semiconductor materials and their use in microelectronics. The students will be also trained to prepare some experiments to characterize semiconductors and simple devices.
2	Course content and Learning outcomes (Dublin descriptors)	Topics of the module include: 1. Semiconductors and the parameters that control their characteristics a. Crystal Structure, electrons, holes, energy gap and effective mass b. Intrinsic vs extrinsic semiconductors c. Direct band gap vs indirect band gap; Narrow vs wide band gap 2. Semiconductor statistics: [a] a. Fermi –Dirac and Maxwell-Boltzmann Distributions, Density of states , Fermi levels 3. Transport in Semiconductors: [a, b] a. Scattering processes, mobility and its temperature and doping level dependence b. Drift and diffusion currents under the influence of electric field c. Generation, recombination, recombination lifetimes 4. Semiconductor devices and their operation principles a. PN Diodes, solar cells and Light emitting diodes b. MOS Capacitors and CCDs c. MOSFET and MOSFET Scaling issues d. Bipolar Junction Transistors 5. Semiconductor device and IC Fabrication processes 6. Laboratory: Hall effect, optical gap, I-V, optical and resistive chemical sensors. Expected Learning Outcomes <u>Acquiring knowledge and understanding</u> As part of this course, students: 1. will understand the physical, electrical, and optical properties of semiconductor materials and their use in microelectronic circuits. 2. relate the atomic and physical properties of semiconductor materials to device and circuit performance issues. 3) operation principles of diodes, MOSFETs, BJT , scaling issues and fabrication processes <u>Making informed judgments and choices = skills</u>. Learn how theory arises from critically analysis of experiments Demonstrate on examination and through homework assignments, proficiency in solving problems Demonstrate the ability to acquire, critically assess the relative merits, and effectively use of appropriate information from a variety of sources <u>Communicating knowledge and understanding</u> Present experimental findings through oral and/or written reports <u>Capacities to continue learning</u> The conceptual basis established will enable students to

		understand related topics. The course would also expand its coverage of semiconductor microelectronic devices into the field of nanoelectronics and can provide the basic information for the recruitment in microelectronics industries
3	Prerequisites and learning activities	Atomic structure, solid state physics (elementary)
4	Teaching methods and language	Lectures where material will be presented and explained, and the subject will be illustrated with demonstrations and examples. Lectures and examples will be both held in Italian Ref. Text books: Besides some lecture notes available on the e-learning site the students may refer Ben Streetman, Sanjay Banerjee *Solid State Electronic Devices* (6th Edition) Prentice Hall
5	Assessment methods and criteria	Midterm Exams, homework assignments, final exam or written term paper with oral presentation