

MATERIALS TECHNOLOGY FOR SUSTAINABLE BUILDING WITH APPLIED CHEMISTRY ELEMENTS (9 CFU) - ACADEMIC YEAR 2021/22

FIRST YEAR BACHELOR PROGRAMME - FIRST SEMESTER

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COURSE DESCRIPTION:

The course is characterized by an interdisciplinary approach and aims to provide students with an in-depth knowledge of some classes of traditional materials (natural waters, metals, ceramics, binders, concrete, wood) and an introduction to the general concepts of sustainability and the discussion of sustainable building materials.

LEARNING OBJECTIVES:

Upon completion of the course, the students will be able to

- Describe the main properties of the studied materials
- Understand the correlation of material properties with composition and microstructure
- Analyze and compare the characteristics and performances between the different classes of materials
- Predict the behavior of materials in use
- Apply the acquired notions to solve numerical problems on topics of engineering interest

Furthermore, it will acquire independent judgment in the:

- Selection of the material in order to increase sustainability
- Evaluation of the Impact and Responsibility of Engineering Practice by studying the mechanisms of interaction between materials and the surrounding environment with attention to materials' life cycles and the release of pollutants from materials in use.

COURSE DESIGN: Due to the COVID-19 emergency, the course will be fully held online using both synchronous and asynchronous activities (according to the timetable reported below).

Asynchronous teaching implies pre-recorded lectures and tutorials to solve exercises, together with a discussion forum. The self-learning must proceed according to the scheduled program.

Live activities (6 hours per week) imply a brief summary of the topics of the pre-recorded class, discussion, and exercise with the teacher or in groups.

For the connection we will use *meet at the link*

<https://meet.google.com/wty-wmqw-brw?pli=1&authuser=0>

This link will be valid for the entire duration of the course.

Some mandatory home assignments to be solved in small groups will be assigned. The solutions will be published or sent by mail.

A virtual classroom has been created <https://classroom.google.com/c/Mzk3NzlwMDMyNDAY?cjc=gbokjsw>

Where all the materials and assignments will be stored and managed. The code is gbokjsw.

Timetable of live classes

Monday 9.00-11.00 italian time

Wednesday 9.00-11.00 italian time

Thursday: 14.30-16.30 italian time

PROGRAM

- FUNDAMENTALS OF CHEMISTRY The atomic structure. Chemical bonds. Chemical Reactions. Aqueous solutions.
- APPLIED CHEMISTRY Structure, composition and characteristics of natural waters. Requirements for a specific use. Treatments.
- MATERIALS Classification, life cycle. The structure of crystalline solids. Crystals Defects. Diffusion. Relationship between structure and properties. Mechanical Properties. Mechanisms of strengthening in metals. Fatigue. Failure.
- METALS Ferrous and non-ferrous alloys. The iron-carbon phase diagram. Microstructure in Iron–Carbon Alloys. Thermal treatments. Bain curves.
- CERAMICS and GLASSES Structure, properties, production and use.
- BINDERS Lime, plaster (production and hardening). Cement: production, cooking, hydration, setting and hardening, heat of hydration, porosity, false setting. Chemical and mechanical tests. Types of cement.
- CONCRETE Mixing water, aggregates, admixtures. The properties and critical issues of fresh and hardened concrete. Mix design. Durability. Green concrete.
- SUSTAINABILITY and SUSTAINABLE MATERIALS Sustainability and construction. Traditional (wood) and novel sustainable materials.

ATTENDANCE: attendance is taken, **expected** and strongly recommended (70% attendance, minimum threshold to take the intermediate exams)

TEXTS/MATERIALS:

- 1) B.A. Averill, P. Eldredge, Principal of general chemistry, pdf free download - *Or any other similar book*,
- 2) W.D. Callister - Materials science and engineering or in alternative W.F. Smith, J. Hashemi – Foundations of Materials Science and Engineering
- 3) Slideshows and pre-recorded classes
- 4) Lecture notes and exercise book

More in detail

Week 1	Monday	Sept. 27 th	9-11	Live	Presentation of the course (program, texts, calendar and methods of evaluation). Simulation of a class.
	Tuesday	Sept. 28 th	12-14	Pre-recorded class 1	Introduction to chemistry and to materials science. The evolution of the atomic model. Orbits and orbitals. Quantum numbers. Pauli and Hund's principles. Electron configuration. Aufbau.
	Wednesday	Sept. 29 th	9-11	Live	Entrance test. Summary and discussion on the topics of class 1 part 1.
	Thursday	Octob. 30 th	14.30-16.30	Live	Summary and discussion on the topics of class 1 part 2.
Week 2	Monday	Octob. 4 th	9-11	Live	Exercises and discussion on the topics of class 1.
	Tuesday	Octob. 5 th	12-14	Pre-recorded class 2	The octet rule. Ions and molecules. The periodic table. The atomic number, mass number, atomic weight. The periodic properties. Chemical Bonding, Lewis structures. Mole, molar mass and molecular weight. Valence. Equivalent weight. Nomenclature.

	Wednesday	Octob. 6 th	9-11	Live	Summary, discussion, and exercises on the topics of class 2 part 1.
	Thursday	Octob. 7 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 2 part 2.
Week 3	Monday	Octob. 11 th	9-11	Live	Exercise and discussion on the topics of class 3.
	Tuesday	Octob. 12 th	12-14	Pre-recorded class 3	Chemical Reactions. Redox reactions. Aqueous solutions. Concentrations. Dissociation. Equilibrium. Solubility.
	Wednesday	Octob. 13 th	9-11	Live	Summary, discussion, and exercises on the topics of class 3 part 1.
	Thursday	Octob. 14 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 3 part 1.
Week 4	Monday	Octob. 18 th	9-11	Live	Exercises on the topics of class 3.
	Tuesday	Octob. 19 th	12-14	Pre-recorded class 4	Solubility product. Acids and bases, pH, hydrolysis, buffer solution.
	Wednesday	Octob. 20 th	9-11	Live	Summary, discussion, and exercises on the topics of class 4 part 1.
	Thursday	Octob. 21 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 4 part 1.
Week 5	Monday	Octob. 25 th	9-11	Live	Exercises and discussion on the topics of class 4.
	Tuesday	Octob. 26 th	12-14	Pre-recorded class 5	Natural Waters: Structure and properties, composition and characteristics (pH, temperature, dissolved oxygen, color, turbidity, conductivity, total dissolved solids, hardness).
	Wednesday	Octob. 27 th	9-11	Live	Summary, discussion, and exercises on the topics of class 5 part 1.
	Thursday	Octob. 28 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 5 part 2.
Week 6	Monday	Novemb. 1 st	9-11	Live	First intermediate test
	Tuesday	Novemb. 2 nd	12-14	Pre-recorded class 6	Carbonate system, acidity and alkalinity. Dissolved gases. Chemical stability, encrusting power and aggressive power. Free and aggressive carbon dioxide. Langelier and Ryznar stability index.
	Wednesday	Novemb. 3 rd	9-11	Live	Summary, discussion, and exercises on the topics of class 6 part 1.
	Thursday	Novemb. 4 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 6 part 2.
Week 7	Monday	Novemb. 8 th	9-11	Live	Exercises and discussion on the topics of class 6.
	Tuesday	Novemb. 9 th	12-14	Pre-recorded class 7	Water requirements for drinking, agriculture, industry. Treatments: neutralization, water softening, ion exchange, reverse osmosis.
	Wednesday	Novemb. 10 th	9-11	Live	Summary, discussion, and exercises on the topics of class 7 part 1.
	Thursday	Novemb. 11 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 7 part 2.
Week 8	Monday	Novemb. 15 th	9-11	Live	Exercises and discussion on the topics of class 7.
	Tuesday	Novemb. 16 th	12-14	Pre-recorded class 8	Materials: classification, life cycle. The structure of crystalline solids. Crystals Defects. Motion of dislocation and deformation of materials. Mechanical Properties: Stress and Strain Behavior, Elastic and plastic deformation, Modulus of Elasticity.

	Wednesday	Novemb. 17 th	9-11	Live	Summary, discussion, and exercises on the topics of class 8 part 1.
	Thursday	Novemb. 18 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 8 part 2.
Week 9	Monday	Novemb. 22 th	9-11	Live	Second intermediate test
	Tuesday	Novemb. 23 th	12-14	Pre-recorded class 9	Strength and Ductility. Toughness, Resilience, Hardness. Mechanisms of strengthening in metals, Ductility and brittleness, Mechanical Tests, Failure (ductile and fragile failure), Fracture toughness, Fatigue and creep behavior.
	Wednesday	Novemb. 24 th	9-11	Live	Summary, discussion, and exercises on the topics of class 9 part 1.
	Thursday	Novemb. 25 th	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 9 part 1.
Week 10	Monday	Novemb. 29 th	9-11	Live	Exercises on the topics of class 9.
	Tuesday	Novemb. 30 th	12-14	Pre-recorded class 10	Ferrous and non-ferrous alloys. Phase diagrams of pure substances and binary systems. The iron-carbon phase diagram. Production of cast irons and steels. Development of Microstructure in Iron–Carbon Alloys. Thermal treatments. Bain curves.
	Wednesday	Decemb. 1 st	9-11	Live	Summary, discussion, and exercises on the topics of class 10 part 1.
	Thursday	Decemb. 2 nd	14.30-16.30	Live	Summary, discussion, and exercises on the topics of class 10 part 1.
Week 11	Monday	Decemb. 6 rd	9-11	Live	Exercises on the topics of class 10.
	Tuesday	Decemb. 7 th		Pre-recorded class 11	Ceramic: Structure, mechanical and thermal properties. Uses. Production, forming and consolidation. Traditional ceramic materials for building. Glasses: Structure, properties, fabrication, classification and uses.
	Wednesday	Decemb. 8 th	9-11	Live	Summary, discussion, and exercises on the topics of class 11 part 1.
	Thursday	Decemb. 9 th	9-11	Live	Summary, discussion, and exercises on the topics of class 11 part 1.
Week 12	Monday	Decemb. 13 th	12-14	Live	Exercises on the topics of class 11.
	Tuesday	Decemb. 14 th	9-11	Pre-recorded class 12	Binders: Lime and plaster (production and hardening). Cement: production, hydration, setting and hardening, chemical and mechanical tests. Types of cement: characteristics, requirements, uses.
	Wednesday	Decemb. 15 th	14-16	Live	Summary, discussion, and exercises on the topics of class 12 part 1.
	Thursday	Decemb. 16 th	9-11	Live	Summary, discussion, and exercises on the topics of class 12 part 1.
Week 13	Monday	Decemb. 20 th	12-14	Live	Third intermediate test
	Tuesday	Decemb. 21 th	9-11	Pre-recorded class 13	Concrete: mixing water, aggregates, admixtures. The properties and critical issues of fresh (workability, segregation and bleeding) and hardened concrete (strength, shrinkage, bleeding, segregation). Mix design. Impact of environment on concrete durability (freeze-

					thaw attack, acid attack, sulfate attack, alkali-aggregate reactions, leaching, corrosion of the reinforcements).
	Wednesday	Decemb. 22 th	14-16	Live	Summary, discussion, and exercises on the topics of class 13 part 1.
	Thursday	Decemb. 23 th	14-16	Live	Summary, discussion, and exercises on the topics of class 13 part 1.
					Sustainability and construction. Traditional sustainable materials: WOOD (Structure, composition, mechanical properties, production, use, requirements and durability).

COURSE EVALUATION/GRADING SYSTEM: students must pass three exercises (the first on the redox reaction, the second on applied chemistry, the third on the properties of materials), and a questionnaire consisting of 30 multiple choice questions, a fill-in-the-blank text with 15 missing words and two short exercises or open questions.

Three intermediate tests will be taken in class during the course (November 2nd, November 23th and December 21st). Those who pass all three intermediate tests are required to answer only the questionnaire.

Those who do not pass the whole exam can repeat only the failed parts and keep their partial grades until the month of September 2021. After that date, all the achieved results will be deleted.

The final mark is expressed in thirtieth /30.

2.5 POINT (8% weight of the final score) as a reward for assiduity, attendance and punctuality in delivering the home assignments

The rest can be achieved by passing:

3 EXERCISES: UP TO 15 POINTS (50% weight of the final score). 5 as the maximum final score and 2.5 as the minimum accepted score for each exercise. For scores below 2.5, the exercise must be repeated.

A QUESTIONNAIRE: UP TO 7.5 POINTS (25% weight of the final score)

Fill- the-gap questions: 15 gaps, 0.2 points each correct answer

Multiple-choice questions: 15 questions, 0.3 points each correct answer

Minimum accepted score: 7. For scores below 7, the test must be repeated.

INTERVIEW: UP TO 5 POINTS (17% weight of the final score)

Oral exam dealing with the mainly theoretic contents

INTERMEDIATE TESTS (academic year 2021/22): November 1st, November 22nd, December 20th

EXAMINATION DATES (academic year 2021/22): January 13th, February 10th, June 7th, July 14th, September 16th