Programme of "Scienza e Tecnologia dei Materiali II"
"Science and Technology of Materials II":

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

- **CODE: I0593**
- **TYPE OF COURSE UNIT: OPTIONAL**
- **LEVEL OF COURSE UNIT: SECOND CYCLE, CHEMICAL ENGINEERING**
- **YEAR OF STUDY: 2ND; SEMESTER: 1ST**

Teacher: **Mario Pelino (Mario.pelino@univaq.it)**

1	**Course objectives and Learning outcomes**	The course aims to provide students with the advanced notions of chemistry and solid state physics applied to the study of materials science and technologies as well as application of materials in different branches of application. Chemical, thermal, and mechanical properties are related to structure, composition, morphology of phases. The properties and applications of ferrous and non-ferrous (aluminium, nickel, copper) of advanced ceramics and glass-ceramics, polymers is detailed. Typical practical applications are presented in the second part of the course. On successful completion of this module, the student should understand the fundamental concepts of solid state chemistry and physics, the properties of engineering materials, the production technology and applications, the basic concepts of materials recycling .
2	**Dublin descriptors**	**Topics of the module include:** Elements of general chemistry , structure of atoms and molecules. Atomic bond of solids. Covalent and ionic solids metallic . The crystal structures . The Miller indices . Plans and directions at maximum density . Solidification. Defects in crystals . X-ray diffraction and Bragg's law . The solids under stress : the movement of atoms in the crystal lattice . Fick's laws of diffusion . Diffusion in metals, in the oxides in the glass. Mechanical tests on materials: strength, fatigue, toughness, hardness, creep . Thermodynamics of solid solutions . The Gibbs phase rule . Partial and complete miscibility . Immiscibility . Characteristic points in the phase diagrams. Diagrams of Fe-C , Al- Cu , Cu -Zn , Cu -Sn . Phase diagrams of silica - alumina. Ternary diagrams . The solidification process . The metal alloys, ferrous : Curves Bain , the isotherms and an- isotherm quenching and tempering , annealing, normalising . The steels, carbon steels. Austenitic stainless steels , ferritic and martensitic steels. Duplex. Solution strengthening . Steels for cryogenic and high temperatures application . The special alloys. The non ferrous alloys : aluminium alloy hardening and work hardening. Alloys by extrusion and reclamation . Anodizing . Alloys of copper. Brass, bronze, cupro-nickel. Nickel alloys: properties, technology and application. The ceramics : Crystalline structures, the structure of silicates, defects in ceramic materials, brittle fracture, stress-strain behaviour, scientific aspects of sintering; fabrication techniques. Traditional and advanced ceramics , thermal and electrical properties . Techniques for inducing toughening in ceramics . Application of advanced ceramics. Properties of glasses, lattice formers and modifiers , the glass transition temperatures, temperature vs viscosity curves. Glass - ceramics : nucleation and crystallisation; properties and applications . Polymers: Polymerization reactions : thermoplastic polymers , thermosetting . The vulcanization process of the elastomers. Basic notions of soldering metals; mechanical and chemical properties modification due to soldering. Basic notions of materials recycling
3	**Prerequisites and learning activities**	Advanced notions of General Chemistry, Physics and Mathematics
4	**Teaching methods and language**	Lectures and exercises. Language: Italian / English **Ref. Text books** • W.F. SMITH - SCIENZA E TECNOLOGIA DEI MATERIALI - MCGRAW-HILL • W. NICODEMI. METALLURGIA - ED. MASSON • W.D. CALLISTER - MATERIALS SCIENCE AND ENGINEERING - JOHN WILEY AND SONS, INC.

5	**Assessment methods**	Oral exam.