UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2018/2019
MASTER'S DEGREE (MSC)	BIOMATERIALS ENGINEERING
INTEGRATED COURSE	POLYMERIC-BASED BIOMATERIALS AND COMPOSITES - INTEGRATED COURSE
CODE	19622
MODULES	Yes
NUMBER OF MODULES	2
SCIENTIFIC SECTOR(S)	ING-IND/22
HEAD PROFESSOR(S)	DINTCHEVA NADKA TZANKOVA — Professore Associato — Univ. di PALERMO
OTHER PROFESSOR(S)	FIORE VINCENZO — Professore Associato — Univ. di PALERMO DINTCHEVA NADKA TZANKOVA — Professore Associato — Univ. di PALERMO
CREDITS	15
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	1
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**DINTCHEVA NADKA TZANKOVA** Tuesday 14:00 16:00 DICAM - Ed. 6, terzo piano Thursday 14:00 16:00 DICAM - Ed. 6, terzo piano **FIORE VINCENZO** Tuesday 09:00 11:00 Viale delle Scienze, Edificio 6, terzo piano, stanza 3012 Thursday 09:00 11:00 Team "Didattica telematica Prof. Fiore" codice: opuh3tj

DOCENTE: Prof.ssa NADKA TZANKOVA DINTCHEVA

PREREQUISITES	In order to understand the topics and to easily achieve the learning goals of the teaching course, the student must be confident with the following subjects: Chemistry, Applied Chemistry and Physics, Production and Properties of Materials, Chemistry and Physics of Matter, Materials Processing Technologies.
LEARNING OUTCOMES	Knowledge and understanding ability The student, at the end of the teaching course, will know the main topics related to the structure and production of several classes of materials: metals, polymers, ceramics and composites. Special attention will be paid to the properties and applications of aforementioned materials. The student, at the end of the teaching course, will know the main classes of biocomposite and nanocomposite materials. The student will have full knowledge of the main types of matrices and reinforcements used for composites and nanocomposites, the main manufacturing technologies and of the methods for the characterization of these materials. Ability to apply knowledge and understanding The student will be able to learn and discuss about: • Matter state of aggregation and molecular structures in solids: amorphous and crystalline materials • Characterization of materials on the base of their physical properties: metals, polymers, ceramics and composites. • Production and properties of metals • Production and properties of polymers • Production and properties of ceramics • Mechanical characterisation of materials • Appropriate choose of materials based on requested application The student will be able to choose the most suitable biocomposite and nanocomposite materials for each application. The student will be able to correlate structure and properties thus choosing the materials according to the suitability to work conditions. Judging autonomy The student will be able to determinate the main physical-chemical properties of different classes of materials. Furthermore, it will be able to identify the appropriate material for a specific application. The student will also be able to discriminate the materials and their main properties and to identify the main methodologies for production and processing. The student will be able to choose the most appropriate material for a certain application based on the requested characteristics. The student will also be able to choose tools and tests necessary to describe the applicability range of a composite and nanocomposite material and the performance of the final device, in both design and verification questions. Communication ability The student will acquire the capability to communicate and express problems inherent the course topics. The student will be able to highlight questions related to the preparation and processing of different materials, exposing the information in an adequate technical language. The student will acquire the capability to communicate and express problems inherent the course topics. The student will be able to highlight questions related to the preparation and processing of different composite and nanocomposite materials, exposing the information in an adequate technical language. The student will also be able to expose the results of a scientific research, to propose suitable systems and to explain eventual project plans connected with them. Learning ability At the end of the course, the student will have learnt how to choose the appropriate material, to characterize it, and to optimize the production conditions. At the end of the course, the student will have learnt how to choose the most suitable composite material for a certain application or device, by evaluating properties and functions. This will allow continuing the studies with improved autonomy, dynamism and with the awareness to be able to make supported choices when realizing potential projects.
ASSESSMENT METHODS	The evaluation will be based on two tasks: a written test and interview. The final assessment is on a 30 basis according to the criteria reported below: 30-30+: excellent knowledge of the topics, excellent language and vocabulary, good analytical capability, the student is able to apply knowledge to solve the proposed problems 26-29: Good management of the topics, nice language and vocabulary, the student is able to apply knowledge to solve the proposed problems 24-25: basic knowledge of the topics, fair language and vocabulary, limited capability to apply autonomously knowledge to solve the proposed problems 21-23: the student does not show full management of the main topics while

	possessing the knowledge, satisfactorily language and vocabulary, poor capability to apply autonomously the acquired knowledge 18-20: minimal basic knowledge of the main topics and of the technical language and vocabulary, poor or no capability to apply autonomously the acquired knowledge. The exam will be not passed if the student will show a not acceptable knowledge of the topics.
TEACHING METHODS	Lectures, Exercises, Laboratory Experience

MODULE
COMPOSITE AND NANO-COMPOSITE BIOMATERIALS

Prof. VINCENZO FIORE

SUGGESTED BIBLIOGRAPHY

- Mallick P.K. Fibre reinforced composites: materials, manufacturing and design. Marcel Dekker Inc.
- Agarwal B.D., Broutman L.J., Chandrashekhara K. Analysis and Performance of Fiber Composites. John Wiley & Sons.
- Pinnavia T.J., Beall G.W. Polymer-clay nanocomposites. John Wiley & Sons.
- Dispense fornite dal docente.

AMBIT	50482-Discipline dell'ingegneria
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54

EDUCATIONAL OBJECTIVES OF THE MODULE

The main goal of the course is to provide students with the skills and the knowledges about the following fundamental aspects of design, processing and applications of nanocomposite and biocomposite materials:
• Main types of matrices and reinforcements;
• Main manufacturing technologies;
• Theoretical/predictive models of mechanical behavior;
• Main experimental techniques for the characterization of mechanical, chemical and physical properties;
• Traditional and innovative industrial sectors

SYLLABUS

Hrs	Frontal teaching
3	Main fiber-reinforced polymer biocomposites structures: laminates and sandwiches
7	Polymeric materials as matrices for composites and biocomposites
5	Synthetic and natural fibers as reinforcement for composites
3	Main manufacturning processes for composites and biocomposites: hand lay-up, vacuum bagging, vacuum infusion, RTM, filament winding, pultrusion
2	Fiber/matrix adhesion: Experimental investigation techniques of fiber/matrix adhesion and its relationship to composite mechanical performances. Wettability and contact angle measurements, surface treatments of synthetic and natural fibers.
6	Micromechanical models for the prediction of elastic properties of composite materials: lamination theory
8	Main fillers for nanocomposites: natural and synthetic clay, hydrotalcites, graphene, carbon nanotubes, polysaccharide nanocrystals. Manufacturing processes for nanocomposites. Main properties and applications of nanocomposite materials.

Hrs	Practice
4	Excercises concerning the theoretical prediction elastic properties of composites via micromechanical models

Hrs	Workshops
16	Practice about manufacturing processes and characterization methods of biocomposite and nanocomposite materials. Experimental characterization of biocomposites and naocomposites.

MODULE PROCESSING TECHNOLOGIES OF POLYMERIC BIOMATERIALS *Prof.ssa NADKA TZANKOVA DINTCHEVA*	
SUGGESTED BIBLIOGRAPHY	
• W.F. Smith, “Scienza e Tecnologia dei Materiali”, Mc Graw Hill 3° ed 2008 • A. Cigada, T. Pastore, “Struttura e proprieta' dei materiali metallici”, McGraw-Hill 2012 • S. Bruckner, G. Allegra, M. Pegoraro, F.P. La Mantia, “Scienza e tecnologia dei materiali polimerici” EdiSES, 2007 • Dispense distribuite dal docente	
AMBIT	50482-Discipline dell'ingegneria
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
EDUCATIONAL OBJECTIVES OF THE MODULE	
The course aims to study the industrial production and the physical-chemical properties of materials, including the main structure – properties – processing relationships. The final part of course will be devoted to the study of the formulation and production of composites materials.	

SYLLABUS

Hrs	Frontal teaching
2	Introduction on the industrial production of materials and their properties
11	Materials structure: - Solid state and crystalline structures, lattice of Bravais, amorphous materials; - Atomic density and density factor; - Structural and morphological characterizations.
18	Metals: - Industrial production of metals, steels and cast iron; - Diagram Fe-C for steels, Diagram TTT Transformation – Time – temperature, Diagram CCT Continuous Cooling Transformation and relationships with state diagram; - Thermal and chemical treatments; - Special steels, inox and cast iron; - Metals corrosion; - Properties of metals, steels and cast iron.
18	Polymers and biopolymers: - Macromolecules: structure and classification; - Reactions of polymerization and their industrial applications; - linear and non-linear viscoelasticity and rheometry; - Properties of polymers in the solid state: optical, mechanical, thermo-mechanical, thermal and morphological properties.
13	Ceramics. - Crystalline structures of ceramics and silicates; - Production and transformation of ceramics; - Electrical, mechanical and thermal properties of ceramics; - Glasses and refractories.
7	Micor- and Nano- Biocomposites: - Classical fibers and particles based composites; - Isotropic and anisotropic properties: micro-mechanics in iso-strain and iso-stress conditions; - Specific examples of composite materials: Portland cement and asphalt; - Micro- and nano-composites: production and applications.

Hrs	Practice
3	Measurement of viscosity and moduli in the molten state
3	Biocomposite materials: calculation of mechanical properties in iso-stress and iso-strain conditions

Hrs	Workshops
3	Static tensile test: measurement of elastic modulus, tensile strength and elongational at break
3	Measurement of impact strength for different materials