

Course unit title:	Introduction to Materials (with Lab)		
Course unit code:	ME107		
Type of course unit:	Compulsory		
Level of course unit:	Bachelor (1st Cycle)		
Year of study:	1		
Semester when the unit is delivered:	1 (Fall)		
Number of ECTS credits allocated :	5		
Name of lecturer(s):	Professor Christodoulos N. Christodoulou		
Learning outcomes of the course unit:	<ol style="list-style-type: none"> 1. Identify the different Types of Materials and many engineering materials and their application, Recognise the Structure – Property – Processing Relationship and suggest ways to produce certain materials with specific properties 2. Draw the Structure of an Atom and recognise its potential chemical behaviour (valence electrons, valence etc), Distinguish among Ionic-Covalent-Metallic Bonding, predict and draw the different type of bonding in many materials 3. Draw a Potential Energy Diagram (Energy as a function of interatomic distance) and explain the attractive and repulsive energies/forces acting on the atoms, Distinguish and explain the nature of Gases – Liquids – Solids in terms of bonding types, binding energy and length of bonding and explain the properties of the materials (thermal expansion, melting point, mechanical stiffness, etc) by using Potential Energy Diagrams (Interatomic Spacing, Binding Energy, deep and shallow energy wells) 4. Recognise the Crystal Structure of Materials (Symmetry, 14 Bravais Lattices) and draw them, Calculate the Directional Density, Planar Density, Bulk Density, Packing Factor of any crystalline material, Recognise the types of Defects in crystals and explain the potential effect of such defects in the mechanical properties of the materials and explain Slip Systems in Crystals and the Influence of Crystal Structure in Slip Process related to the mechanical properties of the materials 5. Read Stress-Strain Diagrams (for Ductile and Brittle Materials, Elastic and Plastic Region, Fracture), Obtain critical to the material parameters (Young's Modulus of Elasticity, Yield Strength, Ultimate Strength, fracture stress, elongation, 0.1% proof stress, 0.2% proof stress, etc), Explain the Strain-Hardening Mechanisms, the Characteristics of Cold/Hot Working and how to apply them in materials and explain the Effect of Annealing on the Mechanical Properties of Cold/Hot Worked Metals (Recovery-Recrystallization-Grain Growth) 6. Explain the types of Testing methods and tools used for testing of materials (Stress vs Strain test, Hardness test, Impact test, microscopes, microstructures etc) 7. Explain and comprehend the Homogeneous Nucleation (Critical Nucleus Size, Activation Energy for Solidification) and show how this applies to materials processing, such as solidification and development of the materials microstructure 8. Explain the Strengthening by Solidification (grain size), the Solid Solution Strengthening by Solidification and Solid-State Diffusion, and the Dispersion Strengthening by Solidification and by Phase Transformations, and suggest applications in engineering materials 		
Mode of delivery:	Face-to-face		
Prerequisites:	None	Co-requisites:	None
Recommended optional program components:	None		

Course contents:	<ul style="list-style-type: none"> • Introduction to Materials <ul style="list-style-type: none"> - Types of Materials - Structure – Property – Processing Relationship • Atomic Structure and Bonding <ul style="list-style-type: none"> - The Structure of the Atom - Ionic-Covalent-Metallic Bonding - Binding Energy and Interatomic Spacing (Potential Energy Diagrams) • Atomic Arrangements <ul style="list-style-type: none"> - Gases – Liquids - Solids - The Crystal Structure of Materials (Symmetry, 14 Bravais Lattices) - Directional Density, Planar Density, Bulk Density, Packing Factor • Imperfections in Crystals – Slip Systems in Crystals <ul style="list-style-type: none"> - Defects - Slip Systems in Crystals (Influence of Crystal Structure in Slip Process) • Physical Properties of Materials in Relation to Bonding and Crystal Structures <ul style="list-style-type: none"> - Potential Energy Well and Properties - Diffusion of Atoms • Mechanical Testing and Properties <ul style="list-style-type: none"> - Stress-Strain Diagrams (for Ductile and Brittle Materials, Elastic and Plastic Region, Fracture) - Properties Obtained from Stress-Strain Diagrams (Young Modulus of Elasticity, Yield Stress, Proof Stress, Ultimate Stress, Necking, Fracture, Elongation) - Testing • Strain Hardening and Annealing <ul style="list-style-type: none"> - Strain-Hardening Mechanisms - Characteristics of Cold Working - Effect of Annealing on the Mechanical Properties of Cold Worked Metals (Recovery-Recrystallization-Grain Growth) • Principles of Solidification <ul style="list-style-type: none"> - Homogeneous Nucleation (Critical Nucleus Size, Activation Energy for Solidification) - Heterogeneous Nucleation (Critical Nucleus Size, Activation Energy for Solidification) • Introduction to Strengthening of Materials and Processing <ul style="list-style-type: none"> - Strengthening by Solidification (grain size) - Solid Solution Strengthening by Solidification and Solid-State Diffusion - Dispersion Strengthening by Solidification and by Phase Transformations • Laboratory (1-hour per week): DTA: Microstructural Observation, Homogeneous and heterogeneous nucleation from supersaturated solutions, Solidification onset (sub-cooling), phase transformation, Enthalpy of solidification.
Recommended and/or required reading:	Lecture Notes (power point presentation) given to students through e-learning
Textbooks:	D. R. Askeland & P. P. Phule, “The Science of Engineering Materials”, Fifth Edition, THOMSON Canada Limited, 2006
References:	W. D. Callister, “Materials Science & Engineering- An Introduction”, Sixth Edition,

	<p>2006</p> <p>J. M. Shackelford, "Introduction to Materials Science for Engineers", Pearson Prentice Hall , Sixth edition, 2005</p> <p>Myer Kutz, "Handbook of Materials Selection", 2002</p>
Planned learning activities and teaching methods:	<ul style="list-style-type: none"> ➤ Lectures for learning the theory and fundamentals in materials ➤ Explaining with specific examples different aspects in materials and solve specific problems ➤ Demonstration of actual materials (Silicon mono-crystals, poly-crystalline metal alloys etc) ➤ Frequent short quizzes (about 8) on previous class lecture in order to enforce the "every day" studying and prepare the students to readily attend the next class lecture ➤ Tutorials, where the students ask further questions on the lectures for better comprehension ➤ Frequent reviews and discussions
Assessment methods and criteria:	<ul style="list-style-type: none"> • Quizzes: 10% • Mid-term Exam: 20% • Laboratory Work: 10% • Final Exam: 60%
Language of instruction:	English
Work placement(s):	No