Course Title	Materials Science and Engineering				
Course Code	ME106				
Course Type	Compulsory				
Level	B.Sc (Level 1)				
Year/ Semester	1st Year / 2nd Semester (Spring)				
Teacher's Name	Prof. Christodoulos N. Christodoulou				
ECTS	5	Lectures / week	3	Laboratories/week	0
Course Purpose	The aim of the course is to introduce to the students the different kind of materials used by engineers, to give them an overall view of the properties (mechanical, thermal etc) of the materials and how these relate to the atomic, crystal structure and microstructure of the materials. To explain the types of strengthening of materials in relation to processing. To explain the Binary and Ternary Phase Diagrams and their relation to strengthening of materials. To study in detail, the Fe-C Phase Diagram, the different phases and equilibrium microstructures. To explain the TTT Diagrams for Steels, the different non-equilibrium microstructures (Perlite, Bainite, Martensite) and show how one can heat-treat steels in order to obtain the desired mechanical properties. To explain the Stainless Steels and Cast Irons. To explain what are Ceramic, Polymer and Composite materials and their properties. To explain the deterioration and failure of metals, their importance and show how to prevent them.				
Learning Outcomes	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. 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 4. Explain 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)				

<table>
<tr><td></td><td colspan="3">5. Describe 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
6. Explain and comprehend the Binary Alloy Phase Diagrams of Completely Miscible Systems (Equilibrium and Non-Equilibrium Cooling Curves, Liquidus, Solidus, Phase Fields, Type of Phases, Lever Rule), calculate the %Phase Composition, %Chemical Composition of Each Phase and draw the corresponding microstructures. Know very well the Cu-Ni Alloy System, Binary Alloy Phase Diagrams of Immiscible Systems Containing Three-Phase Reactions (eutectic, eutectoid, peritectic, peritectoid, monotectic), calculate the %Phase Composition, %Chemical Composition of Each Phase and draw the corresponding microstructures
7. Describe the Fe-C Phases and their Mechanical Properties (Ferrite, Austenite, Cementite, Martensite), comprehend the Time-Temperature-Transformation for Eutectoid Steel (TTT Diagrams) and use it in different applications
8. Explain the various groups of engineering materials available for automotive applications (Ceramics, Polymers, Composites), Discuss the New materials (with particular emphasis on opportunities for reducing weight and cost, and improved fuel efficiency, safety and energy absorption) and recycling vehicles components issues</td></tr>
<tr><td>Prerequisites</td><td>None</td><td>Corequisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="3">• Introduction to Materials
- Types of Materials
- Structure – Property
• Atomic Structure and Bonding
- The Structure of the Atom
- Ionic-Covalent-Metallic -Van der Waals Bonding
• Atomic Arrangements
- Metal structures
- Ceramic structures
- Polymeric structures
• Basic mechanical properties, Stess vs Strain curves, Elastic and plastic behaviour of metals
• Testing of metals (tensile, impact and hardness)
• Non destructive test methods
• Failure of metals. (fracture, fatigue, creep and corrosion)
• Principles of Phase Diagrams and Relationship to Materials Strengthening
- Binary Alloy Phase Diagrams of Completely Miscible Systems (Equilibrium and Non-Equilibrium Cooling Curves, Liquidus, Solidus, Phase Fields, Type of Phases, Lever Rule, %Phase Composition, %Composition of Each Phase, Solid Solution Microstructure). Focus on the Cu-Ni Alloy System.
- Binary Alloy Phase Diagrams of Immiscible Systems Containing Three-Phase Reactions (eutectic, eutectoid, peritectic, peritectoid, monotectic).
• The Iron-Carbon Phase Diagram – TTT Diagrams – Steels and Stainless Steels</td></tr>
</table>

	- Fe-C Phases and their Mechanical Properties (Ferrite, Austenite, Cementite, Martensite) - Time-Temperature-Transformation for Eutectoid Steel (TTT Diagrams) - Steel Design and Properties – Compositions – Heat Treatments – Stainless Steels • Materials for Automotive Engineering - Common materials in vehicle production (Steels, Aluminium, Polymers) - Ceramics for automotives - Recycling considerations - New materials (with particular emphasis on opportunities for reducing weight and cost, and improved fuel efficiency, safety and energy absorption)
Teaching Methodology	Power Point Presentation of Lectures, Questions, Discussion Explanations with examples, Reviews, Quizzes ➢ Lectures for learning the theory and fundamentals in materials engineering ➢ Explaining with specific examples different aspects in materials engineering (phase diagrams etc) 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
Bibliography	**Suggested Textbook:** D. R. Askeland & P. P. Phule, “The Science of Engineering Materials”, Fifth Edition, THOMSON Canada Limited, 2006 **Reference Books:** W. D. Callister, “Materials Science & Engineering- An Introduction”, Sixth Edition, 2006 J. M. Shackelford, “Introduction to Materials Science for Engineers”, Pearson Prentice Hall, Sixth edition, 2005 Myer Kutz, “Handbook of Materials Selection”, 2002
Assessment	• Quizzes: 20% • Mid-term Exam: 20% • Final Exam: 60%
Language	English