Course Title	Materials Engineering (with Lab)				
Course Code	ME110				
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	1
Course Purpose	The purpose of the course is to give the student an overall view of the properties of the materials (metallic, ceramic, composite) used by engineers and how these relate to the processing 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.				
Learning Outcomes	1. 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 2. 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 3. Design a particular Steel or a Stainless Steel, describe how to heat-treat it, what kind of microstructure will develop and what will be its final mechanical properties 4. Explain the different Processing Methods of Advanced Ceramics (Powder metallurgy, milling, die-pressing, Sintering) and the different Classification of Polymers (Thermoplastic, Thermosetting, Elastomers) and their engineering applications 5. Describe the different types of Composite Materials (Particulate, Fiber and Laminar Composites), their processing and suggest different composites for different engineering applications				

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<tr><td></td><td colspan="3">6. Explain the fundamentals of Corrosion (Chemical Corrosion, Electrochemical Corrosion, Oxidation) and use the existing methods to prevent it

7. Describe and obtain Stress vs Strain Curves for specific materials

8. Describe how to make a Metal Alloy

9. Use thermocouples to measure temperature profiles in alloy phase transformations

10. Apply heat-treatments for steel hardening and predict their microstructure</td></tr>
<tr><td>Prerequisites</td><td>ME107</td><td>Corequisites</td><td>None</td></tr>
<tr><td>Course Content</td><td colspan="3">• 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
- 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
• Ceramics
- The Structure of Crystalline Ceramics
- Processing of Advanced Ceramics (Sintering)
• Polymers
- Classification of Polymers (Thermoplastic, Thermosetting, Elastomers)
- Polymer Additives – Forming of Polymers
• Composites
- Introduction (Particulate, Fiber and Laminar Composites)
- Dispersion-Strengthened Composites
- Examples and Applications of Laminar Composites
• Deterioration and Failure of Metals
- Corrosion (Chemical Corrosion, Electrochemical Corrosion, Oxidation)
- Protection Against Corrosion
- Non-destructive Testing Methods

Laboratory (1-hour per week): Preparation of Metal Alloys by melting (Sn-Pb). Experimental determination of cooling curves for three unknown alloys (Pd-Sn), indicating the on-set of primary solidification fields and eutectic temperatures and determination of their specific compositions. Obtaining of the Stress vs Strain Curve for Steel, Aluminum or Brass and determine the Young Modulus of Elasticity and other useful parameters. To perform heat-treatment for hardening steels</td></tr>
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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 (more than 10) 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 • Demonstration Laboratories
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: 10% • Mid-term Exam: 20% • Laboratory Work: 10% (presence is required) • Final Exam: 60%
Language	English