ELEN 102: Engineering Materials

Description:
This course provides the Weapons Engineering Technician with an introduction to the theories and concepts of Materials Science. The structure and mechanical properties of the basic engineering materials (metals, ceramics, polymers, and composites) are described. Methods of destructive and non-destructive testing are discussed. Particular emphasis is placed on steel and metallurgy, ceramics, and polymeric materials.

Learning Outcomes

On succesful completion of this course the student will be able to:

- describe the atomic structure of solids with emphasis on metallic crystals.
- describe the characteristics of the 4 basic engineering materials: metals, ceramics, polymers, and composites
- explain the mechanical properties of materials using the concepts of stress, strain, torsion, compression, tension, flexion, ductility, and brittleness.
- describe various methods of testing solids for hardness, strength, elasticity, and corrosion resistance.
- explain basic metallugical concepts such as phase diagrams, alloying, annealing, hardening, softening, and heat treatment.

Outline:

1. **Structure of Materials**
   - **1.1. Atomic Theory**
   - **1.2. The Chemical Bond**
     - 1.2.1. Covalent
     - 1.2.2. Ionic
     - 1.2.3. Metallic
     - 1.2.4. Van der Waals
   - **1.3. Classification of Engineering Materials**
     - 1.3.1. Metals
     - 1.3.2. Polymers
     - 1.3.3. Ceramics
     - 1.3.4. Composites
   - **1.4. Crystal Structures**
     - 1.4.1. Crystalline versus Amorphous
     - 1.4.2. The Crystal Lattice
     - 1.4.3. Allotropes
     - 1.4.4. Grains and Grain Boundaries
     - 1.4.5. Crystal Imperfections and Defects
   - **1.5. Metallic Crystals**
     - 1.5.1. Metallography
     - 1.5.2. Elastic and Plastic Behaviour

1.5.3. Mechanisms for Deformation

1.6. Polycrystalline Materials

1.6.1. Slip
1.6.2. Cold Work (Work Hardening)
1.6.3. Crystal Variables that Affect Properties

2. Mechanical Properties of Materials and Testing Methods

2.1. The Mechanical Properties

2.1.1. Ductility
2.1.2. Malleability
2.1.3. Brittleness
2.1.4. Elasticity
2.1.5. Plasticity
2.1.6. Resilience
2.1.7. Toughness
2.1.8. Hardness

2.2. Material Testing Principles

2.2.1. Purpose
2.2.2. Quality Control versus Quality Assurance
2.2.3. Destructive versus Non-Destructive Testing
2.2.4. Load types on Machine Elements
2.2.5. Stress and Strain
2.2.6. Effect of Work Hardening

2.3. Stress and Strain

2.3.1. Concepts
2.3.2. Stress and Strain Graphs
2.3.3. Engineering versus True Stress/Strain

2.4. The Tensile Test
2.5. The Compression Test
2.6. The Shear Test
2.7. The Torsion Test
2.8. The Flexure Test
2.9. The Creep Test
2.10. The Weld Test
2.11. The Hardness Test
2.12. The Impact Test
2.13. The Fatigue Test

2.14. Non-Destructive Testing (NDT)

2.14.1. Why?
2.14.2. NDT Methods

3. Metallurgy and Metals

3.1. Phase Diagrams and Metallic Systems

3.1.1. The Phase Diagram
3.1.2. Binary Isomorphous Systems
3.1.3. Binary Eutectic Systems

3.2. The Iron- Iron Carbide Phase Diagram

3.2.1. Interpretation of the Iron – iron carbide Phase Diagram

3.2.2. Classifying Iron and Steel
3.2.3. Eutectoid and Eutectic Reactions
3.2.4. Hypoeutectoid and hypereutectoid steel
3.2.5. Effects of Alloying Elements in Iron
3.2.6. The Nomenclature of Steels
3.2.7. Classification of Cast Irons
3.2.8. Characteristics of Non-Ferrous Metals

3.3. Heat Treatment of Steel

3.3.1. Definition and Purpose
3.3.2. Hardening
3.3.3. Softening
3.3.4. Conditioning

4. Polymers

4.1. Bonding Mechanisms And Primary Elements
4.2. Chain Geometry
4.3. Polymerization Processes

4.3.1. Addition Polymerization
4.3.2. Co-polymerization
4.3.3. Condensation Polymerization

4.4. Function Of Additives
4.5. Classification Of Polymers

4.5.1. Thermoplastics
4.5.2. Thermosetting
4.5.3. Elastomers

4.6. Properties Of Polymers

5. Ceramics

5.1. General Characteristics

5.1.1. Elements and Bonding Mechanisms
5.1.2. Chain Formations

5.2. Processing and Fabrication

5.2.1. Sintering
5.2.2. Vitrification
5.2.3. Cermets
5.2.4. Ceramic Coating

5.3. Properties

6. Corrosion

6.1. The Nature of Corrosion

6.1.1. Corrosion and Erosion
6.1.2. Factors affecting Corrosion
6.1.3. Electro-chemical corrosion

6.2. Corrosion of Iron and Steel

6.2.1. Wet corrosion
6.2.2. Dry Corrosion
6.2.3. Single metal corrosion mechanism

6.3. Types of Corrosion

6.3.1. Corrosion in metals
6.3.2. Corrosion in ceramics
6.3.3. Corrosion in polymers

6.4. Biological Corrosion

6.5. Corrosion Control

6.5.1. Factors involved in corrosion control
6.5.2. Passive corrosion control
6.5.3. Active corrosion control
6.5.4. Biological corrosion control

Evaluation:

Assignments and Quizzes	20 %
Term Tests (2?)	40 %
Final Exam	40 %
Total	100 %

Note: To pass this course with a C (minimum passing grade), an overall mark of 60% is required. This includes a minimum of 50% on the Final Exam.

Grading:

As per Camosun College policy

Text and References:

No required text. Readings and references will be supplied as required.