

**UNIVERSITY OF CHEMICAL TECHNOLOGY AND METALLURGY**

**FACULTY OF METALLURGY AND MATERIALS SCIENCE**

**DEPARTMENT OF PHYSICS METALLURGY AND HEAT EQUIPMENT**

**Approved by**

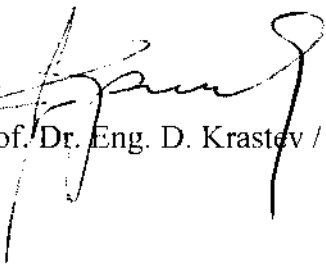
**Dean:** Assoc. Prof. Dr. Eng. I. Gruev

**SYLLABUS**

Subject: **“ENGINEERING ALLOYS”**

Speciality: **“MATERIALS SCIENCE AND ENGINEERING”**

Educational Degree: **“M.Eng.”**

Created by   
/ Assoc. Prof. Dr. Eng. D. Krastev /

Head of Department  
/Prof. D.Sc. D. Angelova/

Sofia, 2006

## SYLLABUS

### Subject: "Engineering Alloys"

#### I. Horarium

Classes	Term	Hours
1. Lections	III	20
2. Exercises	III	20
3. Control	Examination	

#### II. Annotation

The course is designed for the students from M.Eng. Degree in Materials Science and Engineering and familiarizes them with the various types of major engineering alloys and their applications. It provide some understanding of metallurgical structures, their relations to the mechanical properties of engineering alloys and how various heat treatments and processing techniques cause changes in the structure and properties. This course gives a reference for material selection for engineering design and for further in-depth study.

#### III. Lections

- 1. Iron-Carbon Alloys.** 3 h.
  - The Fe-Fe<sub>3</sub>C Alloy System. Critical Temperatures. Eutectoid, Hypoeutectoid and Hypereutectoid Plain-Carbon Steels.
  - Phase Transformations in Plain-Carbon Steels. Pearlite. Martensite. Bainite. Continuous-Cooling Transformation Diagrams.
  - Annealing and Normalizing of Plain-Carbon Steels. The Cold-Worked State. Recrystallization.
  - Quench Hardening of Plain-Carbon Steels.
  - Tempering of Plain-Carbon Steels.
  - Classification of Plain-Carbon Steels.
  - Non-Heat-Treatable Low-Carbon Sheet Steel. Chemical Composition. Heat Treatment and Microstructure. Continuous Annealing of Low-Carbon Sheet Steels. Mechanical Properties.
  - Quench Aging and Strain Aging of Carbon Steels.
  - Hardenable Carbon Steels. Low-Carbon, Medium-Carbon and High-Carbon Steels.
  - Microalloyed Steels. Precipitation Mechanisms in Microalloyed Steels. Strengthening of Microalloyed Steels.
  
- 2. Alloy Steels** 1 h.
  - Effect of Alloying Elements in Alloy Steels.
  - Distribution of Alloying Elements in Alloy Steels.
  - Classification of Alloy steels.

- 3. Alloy Structural Steels** 2 h.
- Manganese Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Low-Alloy Chromium Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Molybdenum Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Chromium-Manganese Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Chromium-Molybdenum Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Chromium-Vanadium Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Nickel-Chromium Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Nickel-Chromium-Molybdenum Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
  - Nickel-Silicon-Chromium-Molybdenum Steels. Chemical Compositions. Structures. Mechanical Properties. Applications.
- 4. Tool Steels** 3 h.
- Classification of Tool Steels.
  - Water-Hardening Tool Steels. Chemical Compositions. Heat Treatment and Microstructures. Typical Applications.
  - Shock-Resistant Tool Steels. Chemical Compositions. Heat Treatment and Microstructures. Typical Applications.
  - Cold-Work (Oil-Hardening) Tool Steels. Chemical Compositions. Heat Treatment and Microstructures. Typical Applications.
  - Cold-Work (Medium-Alloy, Air-Hardening) Tool Steels. Chemical Compositions. Heat Treatment and Microstructures. Typical Applications.
  - Cold-Work (High-Carbon, High-Chromium) Tool Steels. Chemical Compositions. Heat Treatment and Microstructures. Typical Applications.
  - Hot-Work Tool Steels. Chemical Compositions. Heat Treatment and Microstructures. Typical Applications.
  - High-Speed Tool Steels. Chemical Compositions and Typical Applications. Tungsten-Type High-Speed Tool Steels. Molybdenum-Type High-Speed Tool Steels. Heat Treatment and Microstructures.
- 5. Stainless and Heat-Resistant Steels** 3 h.
- Iron-Chromium-Carbon Alloys.
  - Iron-Chromium-Nickel-Carbon Alloys.
  - Classification of Stainless and Heat-Resisting Steels.
  - Ferritic Stainless Steels
  - Martensitic Stainless Steels.
  - Austenitic Stainless Steels.
- 6. Cast Irons** 1 h.
- Classification of Cast Irons.
  - White Cast Iron.

- Gray Cast Iron. Classes of Gray Cast Iron. Chemical Compositions. Microstructures. Engineering Properties.
- Ductile Cast Iron. Chemical Compositions. Heat Treatment. Microstructures. Engineering Properties.
- Malleable Cast Iron. Types of Malleable Cast Iron. Heat Treatment. Microstructures. Engineering Properties.

- 7# Aluminum Alloys** 3 h.
- Classification and Temper Designation of Aluminum Alloys.
  - Commercially Pure Aluminum. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Aluminum-Manganese Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Aluminum-Magnesium Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Aluminum-Copper Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Aluminum-Magnesium-Silicon Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Aluminum Casting Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
- 8. Copper Alloys** 3 h.
- Classification of Copper Alloys.
  - Wrought Copper. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Copper-Zinc Alloys. Chemical Compositions. Structure. Mechanical Properties. Corrosion of Brasses. Typical Applications.
  - Copper-Tin Alloys. Wrought Copper-Tin Bronzes. Cast Copper-Tin Bronzes.
  - Copper-Aluminum Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
  - Copper-Silicon Alloys. Chemical Compositions. Structure. Mechanical Properties. Typical Applications.
- 9 Titanium, Magnesium and Nickel Alloys** 1h.
- Titanium and Titanium Alloys. Classification and Typical Applications.
  - Magnesium Alloys. Classification and Typical Applications.
  - Nickel and Nickel Alloys.

#### **IV. Exercises.**

1. Annealing and Normalizing of Plain-Carbon Steels. Microstructures. 2 h.
2. Quench Hardening of Plain-Carbon Steels, Alloy Constructional Steels and Tool Steels. Microstructures and Properties. 4 h.

3. Tempered Plain-Carbon Steels, Alloy Constructional Steels and Tool Steels. 4 h.

Microstructures and Properties.

4. Stainless Steels. Microstructures and Properties. 2 h.
5. Aluminum Alloys. Heat Treatment and Microstructures. 2 h.
6. Copper Alloys. Heat Treatment and Microstructures. 2 h.
7. Selection of Alloys for Engineering Solutions. 4 h.

### **V. Books**

1. Smith W.F., Structure and Properties of Engineering Alloys. McGraw-Hill, 1993.
2. Henkel D. and A. Pense, Structure and Properties of Engineering Materials. McGraw-Hill, 2001.
3. Smallman R. E., R. J. Bishop, Modern Physical Metallurgy and Materials Engineering. Butterworth-Heinemann, 1999.
4. Ray M. S., The technology and applications of engineering materials. Prentice-Hall International, 1987.
5. Higgins R.A. Engineering Metallurgy. Buterworth-Heinemann, 1993