UNIVERSITY OF CHEMICAL TECHNOLOGY AND METALLURGY

FACULTY OF METALLURGY AND MATERIALS SCIENCE

DEPARTMENT OF PHYSICSL METALLURGY AND HEAT EQUIPMENT

Approved by
Dean: Assoc. Prof. Dr. Eng. I. Gruev

SYLLABUS

Subject: **"HIGH PERFORMANCE 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: "High Performance Alloys"

I. Horrarium

Classes	Term	Hours
1. Lections	III	30
2. Exercises	III	10
3. Control	Current control	

II. Annotation

The course is designed as an optional for the students from M.Eng. Degree in Materials Science and Engineering and familiarizes them with the various types of high performance alloys and their applications. It is a logical and obligatory addition to Engineering Alloys course when a deeply knowledge in alloys and their application is necessary. The course provides understanding of the chemical composition, microstructure, properties and applications of a large numbers of high performance alloys.

III. Lections

1. What is "High Performance"? 4 h.

- Light Weight, High Strength, Toughness, Hardness, High Corrosion Resistance, High Temperature Capability.
- Mechanical Properties of Metals and Alloys. Strengthening Mechanisms.
- Alloy Structures. Phase Diagrams and Phase Transformations. Microstructural Development.

2. Light Alloys 8 h.

- Magnesium Alloys. Cast and Wrought Magnesium Alloys. Magnesium-Aluminum Casting Alloys. Magnesium-Aluminum-Zinc Casting Alloys. Magnesium-Zinc-Zirconium and Magnesium-Zinc-Rare Earth-Zirconium Casting Alloys. High-Temperature Magnesium Casting Alloys. Wrought Magnesium Alloys. Engineering Design with Magnesium Alloys.
- Titanium Alloys. α- and β-Stabilized Systems. α-Titanium Alloys – Chemical Composition, Microstructure, Properties and Applications. Near-α-Titanium Alloys – Chemical Composition, Microstructure, Properties and Applications. α-β-Titanium Alloys – Chemical Composition, Microstructure, Properties and Applications. β-Titanium Alloys – Chemical Composition, Microstructure, Properties and Applications. Some Recent Titanium Alloy Developments.
- Aluminum Alloys. Types of Aluminum Alloys. 5000 Series. 2000 Series. 7000 Series. 8000 Series.

3. **High Temperature Alloys** 8 h.

- Nickel-Base Superalloys. Chemical composition and Typical Applications. Microsthucture. High-Temperature and Stress-Rupture Properties. Hot Corrosion.
- Nickel-Iron-Base Superalloys. Chemical composition and Typical Applications. Microsthucture. High-Temperature and Stress-Rupture Properties.
- Cobalt-Base Superalloys. Chemical composition and Typical Applications. Microsthucture. High-Temperature and Stress-Rupture Strength.
- Creep-Resistant Steels.
- Resistance Heating Alloys.
- Refractory Metals and Alloys. Niobium and Its Alloys. Tantalum and Its Alloys. Molybdenum and Its Alloys. Tungsten and Its Alloys.
- High Temperature Intermetallics.

4. **Alloys with High Strength, Toughness, Hardness and Wear Resistance** 8 h.

- High Performance Steels. High Strength Steels. Dual Phase Steels. Maraging Steels. Wear-Resistant Steels. Baianitic Steels. High Alloy Tempered Martensites. TRIP Steels. Precipitation-Hardening Stainless Steels.
- High Performance Cast Iron. Abrasion-Resistant Alloy Cast Iron. Corrosion-Resistant Cast Iron. Heat-Resistant Alloy Cast Iron. Austempered Ductile Cast Irons.
- High Performance Copper Alloys. Copper-Nickel Alloys. Copper-Nickel-Zinc Alloys. Copper-Beryllium Alloys.
- Hard Metals. Cemented Carbides. Production. Classification. Microstructure. Engineering Properties.

5. **Ultra-Fine Grained and Nanostructured Alloys.** 2 h.

- Methods for Producing. Properties and Applications.

IV. Exercises.

1. Microstructure of Magnesium and Titanium Alloys. 2 h.
2. Precipitation-Strengthening Heat Treatment and Microstructure of Aluminum-Copper Alloys. 2 h.
3. Microstructure of Alloys with High Hardness and Wear Resistance. 2 h.
4. Microstructure and Properties of Nickel-Base and Cobalt-Base Superalloys. 2 h.
5. Selections of Resistance Heating Alloys. 2 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. Schatt W. E. Simmchen, G. Zouhar, Konstruktionswerkstoffe des Maschinen- und Anlagenbaues.Wiley-VCH,1998.
4. Smallman R. E., R. J. Bishop, Modern Physical Metallurgy and Materials Engineering, Butterworth-Heinemann, 1999.
5. Конструкционные материалы. Справочник под общ. ред. Б. Н. Арзамасова, Машиностроение, Москва, 1990.