Course Syllabus

Department/Faculty
School of Engineering

Graduate Program
Materials Engineering and Nanotechnology

Degree
☒ Academic Master's ☒ Doctorate (PhD) ☐ Professional Master's

Course Name
Steel and Special Alloys

Professor (s)

Office hours
48

Course Overview

The course deals initially and in general with carbon steels, their microstructures, properties and applications. The main focus is on special steels. Tool steels are discussed based on their main applications: cold working, shock resistant, hot working, mold steels and high speed steels. Some relevant aspects of Stainless steels are also presented in a broad way, dealing with the different types (austenitic, ferritic, martensitic duplex and precipitation hardening), their microstructures, properties and applications. In addition to steels the classes, also deals with special alloys.
Within this class, nickel and cobalt-based super alloys are discussed taking into account their properties at high and at very low temperatures. The heat treatments and microstructures of the superalloys are discussed with a view to the various applications possibilities. Alloys with shape memory effect are presented with an emphasis on shape reversal due to the thermoelastic martensitic transformation. Intermetallic alloys are treated in terms of their main characteristic of excellent mechanical resistance and corrosion at high temperatures, but low ductility at room temperature.

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Program content:

• Carbon steels: Effect of alloying elements. New technologies to optimize its mechanical properties by microstructure control.

• Tool steels: Classification: cold working, shock resistant, hot working, mold steels, high speed steels. Effect of alloying elements. The power metallurgy technology spreading the chemical composition ranges leading optimization on mechanical and tribological properties.

• Stainless steels: Classification: austenitic, ferritic, martensitic, duplex and precipitation hardenable. Effect of alloying elements on the microstructures.

• Super alloys: Nickel and cobalt based super alloys. High temperature applications and aggressive environments. Heat treatments for solubilization and aging. Characteristics of its microstructure, intermetallic compounds, carbides, inclusions.

• Alloys with shape memory effect: Applications of alloys with shape memory. Ni-Ti alloys almost equiatomic. Plastic deformation below the transformation / reversion temperature to the original shape due to Martensitic thermo-elastic transformation, pseudoelasticity.

• Intermetallic alloys: long range ordered crystalline structures. Titanium, iron, and nickel aluminides. Applications of intermetallic alloys. Mechanical and creep resistance properties at high temperatures and low ductility at room temperature. Properties of resistance to oxidation and corrosion.

Letter Grade Assignment
Grade A (Excellent) - Grade points between 9 and 10
Grade B (Good) - Grade points between 8 and 8.9
Grade C (Satisfactory) - Grade points between 7 and 7.9
Grade D (Unsatisfactory) - Grade points between 0 and 6.9

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Texts, Materials, and supplies

LEXCELLENT C. Shape-memory Alloys Handbook. John Wiley & Sons, Inc., 2013.
ARTINI, C. Alloys and Intermetallic Compounds from Modeling to Engineering. CRC Press, 2017.
HASHMI, S. Comprehensive Materials Processing, Vol 12 - Thermal Engeenering of Steel Alloy Systems. Elsevier. 2014.
CEVIK, S. Superalloys for Industry Applications. InTech Open. 2018.
Jon L. Dossett,
TOTTEN, G.E .. ASM Handbook - Steel Heat Treating Technologies. ASM International. 2014.
HONEYCOMBE, R. W. K., BHADESHIA, H.K.D.H Steels Microstructure and Properties. 3rd Edition, Elsevier Inc, 2006.
ROBERTS, G; KRAUSS, G .; KENNEDY, R. Tool steels. 5th Edition, ASM International, 1998.

Complementary Bibliography

DAVIS, J. R. (Ed.) ASM Specialty Handbook - Nickel, Cobalt and Their Alloys. ASM International, 2000.
REED, C. R. The Superalloys: Fundamentals and Applications, 2nd Edition, London, Cambridge University Press, UK, 2006.
DAVIS, J. R. (Ed.) ASM Specialty Handbook - Heat-Resistant Materials. ASM International, 1997.