UNIVERSIDAD PONTIFICIA ICAI ICADE COMILLAS MADRID

ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA

DIM-GITI-341 Materials Engineering

SEMESTER: Spring

CREDITS: 6 ECTS (4 hrs. per week: 4 hours per week of theory during first 7 weeks; 2 hours of theory and 2 hours of laboratory during the last 8 weeks)

LANGUAGE: Spanish

DEGREES: GITI

Course overview

This course provides an approach to principles of heat treatment, selection, and performance of engineering alloys. Alloy classes, design, structure-property relationships, etc. will be discussed. A fundamental understanding of the basic concepts of fracture mechanics, fatigue and creep. Besides, an introduction of mechanical properties of polymers and composites will be studied.

Prerequisites

Basic knowledge of chemistry and materials science.

Course contents

Theory:

1. Strengthening mechanisms: Solid solution strengthening. Strengthening by grain size. Hall-Petch law. Strain hardening. Precipitation hardening.
2. Kinetics of phase transformations: Kinetics–nucleation and growth. Austenite transformations. Eutectoid structures. Temperature effect on the austenite transformation. Martensitic transformation. Bainitic transformation. Introduction to TTT diagrams: isothermal and continuous cooling diagrams.
3. Recrystallization. Static and dynamic recrystallization. Annealing of cold-worked metal. Effect of time and temperature. Recovery. Grain growth.
4. Metal alloys. Steels and cast irons. White, gray, malleable, ductile cast irons. Low alloy steels. High alloy steels.. High speed steels. Aluminum alloys, Titanium and magnesium alloys. Copper-based alloys. Super alloys.
5. Heat treatment. Austenizing. Annealing. Quenching. Hardenability. Jominy test. Tempering. Surface treatments. Case hardening. Induction hardening.
6. Fracture. Ductile and brittle fracture. Ductile-brittle transition temperature. Charpy test. Linear elastic fracture mechanics. Fracture toughness testing. CT and SENB tests. Fatigue and creep. Fatigue. S-N

curves, ε-N and da/dN. Fatigue crack growth. Paris Law. Creep. Stress and temperature effects. Mechanical behavior of polymers and composites.

7. Materials selection. Ashby charts. Basic concepts on programming.

Laboratory:

Each unit described previously has at least one associated lab practice (2 hours/week)

P1. Determination of mechanical properties by NDT
P2. Precipitate hardening
P3. Materials selection II
P4. Heat treatment of ferrous alloys I - Hardenability test. Jominy test.
P5. Fracture: Impact test. Fracture mechanics (SENB test)
P6. Heat treatment of ferrous alloys II - Hardenability test. Jominy test.
P7. Materials selection III
P8. Fracture. Computer calculations.

Textbook

- D.R.H. Jones and M.F. Ashby, Engineering Materials, Fourth Edition. Oxford, Butterworth Heineman, 2012.
- R. E. Smallman, R J Bishop. Modern Physical Metallurgy and Materials Engineering. Eighth Edition, Butterworth-Heinemann. (2013)
- William D. Callister, David G. Rethwisch. Ciencia e Ingeniería de Materiales. 2º edición, 2016. Editorial Reverte.

Grading

The following conditions must be accomplished to pass the course:

- A minimum overall grade of at least 5 over 10.
- A minimum grade in the final exam of 4 over 10.

The overall grade is obtained as follows:

- Final exam 50%.
- Other exams 25%. Typically 2 short exams (1-hour long).
- Performance during the lab sessions 25%.

Additional evaluation during July (Retake): Regular assessments and laboratory marks will be preserved.

- 70% July exam
- 10 % Laboratory
- 20% Regular assessments