ETY 605. Physical Metallurgy II

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETY 605	**SEMESTER**	6th
COURSE TITLE	Physical Metallurgy II		

INDEPENDENT TEACHING ACTIVITIES *if credits are awarded for separate components of the course, e.g. lectures, laboratory exercises, etc. If the credits are awarded for the whole of the course, give the weekly teaching hours and the total credits*	**WEEKLY TEACHING HOURS**	**CREDITS**
Lectures and exercises	4	4
Add rows if necessary. The organization of teaching and the teaching methods used are described in detail at (d).		

COURSE TYPE *general background, special background, specialized general knowledge, skills development*	Special Background
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	-
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/course/view.php

(2) LEARNING OUTCOMES

Learning outcomes

The course learning outcomes, specific knowledge, skills and competences of an appropriate level, which the students will acquire with the successful completion of the course are described.

Consult Appendix A

- *Description of the level of learning outcomes for each qualifications cycle, according to the Qualifications Framework of the European Higher Education Area*
- *Descriptors for Levels 6, 7 & 8 of the European Qualifications Framework for Lifelong Learning and Appendix B*
- *Guidelines for writing Learning Outcomes*

The main learning objectives of the course are the understanding, familiarization and acquisition of fundamental concepts of Physical Metallurgy (three phase reactions, equilibrium and non-equilibrium phase transformations, heat treatments of alloys). Analytically, the learning objectives are:

- Detailed analysis of and training in all types of binary metallic systems and the respective phase diagrams.
- Detailed analysis of the Fe-C phase diagram, referring to steel, an alloy of the outmost importance. The main types of phase transformations, the respective heat treatments, the attained microstructures and their characteristic properties are analyzed.
- Teaching and understanding of time-temperature-transformation diagrams and continuous cooling transformation diagrams for carbon steels and alloy steels. Teaching is

carried out through many examples and exercises, in order for the students to be able to select the appropriate thermal treatment leading to the desired microstructure and the respective properties.
- Teaching of the principles and processes of age hardening, which is the most important heat treatment of precipitation hardenable alloys.

The main learning outcomes of the course:

- The course applies knowledge acquired from the precursor course of "Physical Metallurgy I". It constitutes the basic background for the selection of proper fabrication and treatment routes for the production of metallic materials with desirable properties as well as the understanding of structure and performance of metallic materials.
- The knowledge acquired from "Physical Metallurgy II" will be used as a base for the following courses specialized in metallic materials ("Engineering Alloys", "Corrosion and Protection", "Aluminum Technology", "Metal Forming", "Welding Technology" and "Powder Metallurgy").
- The course covers the necessary scientific background for the future Materials Engineer to be able to face challenges in matters of metallic materials.
- In particular, the student that has successfully attended the course, is expected to have acquired understanding, familiarization with and knowledge of the fundamental concepts of Physical Metallurgy.

Skills and competences of the students upon successful completion of the course: Upon the successful completion of the course, the student is able to:

- design/select the appropriate heat treatment for the attainment of the appropriate microstructure with the desirable properties.
- forecast which alloy can be subjected to what treatment and what are the expected properties.
- evaluate the ability of the application of an alloy with respect to its properties in certain application fields.
- forecast the performance of a metallic material in various application fields and take measures against potential challenges.
- recognize phases in metallic materials and their effect on the materials properties

General Competences

Taking into consideration the general competences that the degree-holder must acquire (as these appear in the Diploma Supplement and appear below), at which of the following does the course aim?

Search for, analysis and synthesis of data and information, with the use of the necessary technology	*Project planning and management*
Adapting to new situations	*Respect for difference and multiculturalism*
Decision-making	*Respect for the natural environment*
Working independently	*Showing social, professional and ethical responsibility and sensitivity to gender issues*
Team work	*Criticism and self-criticism*
Working in an international environment	*Production of free, creative and inductive thinking*
Working in an interdisciplinary environment	*……*
Production of new research ideas	*Others…*
	…….

- Working independently
- Respect for the natural environment
- Production of new research ideas
- Production of free, creative and inductive thinking
- Search for, analysis and synthesis of data and information, with the use of the necessary technology

(3) SYLLABUS

- Introduction: Fundamental concepts of alloys, state of the alloy, equilibrium state, phase rule

- Fully miscible systems and eutectic systems in metallurgical processes,
- Dispersion strengthening
- Three-phase equilibrium reactions: Intermetallic compounds, peritectic, monotectic, eutectoid, peritectoid reactions,
- Complex phase diagrams in bimetal systems,
- Equilibrium transformations in the Fe-C system: Fe-Fe_3C phase diagram,
- Introduction into the properties and applications of steels,
- Introduction into the phase transformations in steels: Transformation types, Diffusion transformation stages,
- Isothermal transformation diagrams (Time-Temperature-Transformations),
- Diffusion transformations in steels: Pearlitic transformation, Bainitic transformation,
- The martensitic transformation in ferrous and non-ferrous alloys,
- TTT diagrams for carbon hypo-eutectoid and hyper-eutectoid steels,
- TTT diagrams for alloy steels,
- Continuous-Cooling-Transformations and CCT diagrams for eutectoid and non-eutectoid carbon steels and alloy steels,
- Heat treatments of steels: Annealing processes, Martensitic quench and tempering, Martempering, Austempering
- Age hardening

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Power-point, MS Teams, e-course, e-mails
TEACHING METHODS *The manner and methods of teaching are described in detail.* *Lectures, seminars, laboratory practice, fieldwork, study and analysis of bibliography, tutorials, placements, clinical practice, art workshop, interactive teaching, educational visits, project, essay writing, artistic creativity, etc.* *The student's study hours for each learning activity are given as well as the hours of non-directed study according to the principles of the ECTS*	
STUDENT PERFORMANCE EVALUATION *Description of the evaluation procedure* *Language of evaluation, methods of evaluation, summative or conclusive, multiple choice questionnaires, short-answer questions, open-ended questions, problem solving, written work, essay/report, oral examination, public presentation, laboratory work, clinical examination of patient, art interpretation, other* *Specifically-defined evaluation criteria are given, and if and where they are accessible to students.*	LANGUAGE OF EVALUATION: Greek METHOD OF EVALUATION: (i) Written examination at the end of the semester consisting of exercises, problems and judgement questions (ii) During the course the students are asked to solve problems and exercises (volunteer work)

Activity	***Semester workload***
Lectures	52 h
Student's study hours	48 h
Course total	***100 h***

(5) SUGGESTED BIBLIOGRAPHY

-Suggested books:

1. A. Lekatou, Phase Transformations in Metals, Theodoridi Publications, Ioannina 2009.
2. G.N. Haidemenopoulos, Physical Metallurgy, Tziolas Pub., Thessaloniki, 2007.
3. W. Callister, Science & Technology of Materials, Tziolas Pub., Thessaloniki, 2004.
4. G. Chrysoulakis, D. Pantelis, Science & Technology of Metallic Materials, Papasotiriou Pub., Athens 1996
5. G.K. Triantafyllidis, Physical Metallurgy for the Metallurgical Engineer and the Materials Technologist, Tziolas Pub., Thessaloniki, 2012.
6. J.F. Shackelford, Introduction to Materials Science for Engineers, 5th ed., 2000, NJ, USA, Prentice-Hall.
7. K.G. Budinski, M.K. Budinski, Engineering Materials, Properties and Selection, 7th ed., 2002, USA, Pearson Education
8. P.L. Mangonon, The Principles of Materials Selection for Engineering Design, 1999, NJ, USA, Prentice Hall.
9. D.R. Askeland, The Science and Engineering of Materials, 3rd ed., 1994, Boston, PWS Publishing Co.
10. U.C. Jindal, Atish Mozumder, Material Science and Metallurgy, 2012, Pearson
11. D.A. Brandt, J. C. Warner, Metallurgy Fundamentals, 5th ed., 2009, Goodheart-Wilcox Pub.
12. Sir Alan Cottrell, An Introduction to Metallurgy, 2nd ed., 1997, Routledge Pub.
13. J.W. Martin, Precipitation Hardening, 2nd ed., 1998, Butterworth Heinemann, 0 7506 3885 0.

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-Relevant scientific journals:

1. Materials Science & Engineering
2. Materials & Metallurgical Transactions
3. Journal of Materials Engineering & Performance
4. Ironmaking & Steelmaking
5. Steel research
6. Canadian Metallurgical Quarterly
7. The Journal of The Minerals, Metals & Materials Society (TMS)
8. Journal of Alloys and Compounds
9. Materials & Design
10. Advanced Engineering Materials
11. Metals-MDPI
12. Materials-MDPI
13. Crystals-MDPI

et al.

-Websites

http://www.materialstoday.com/
http://www.bssa.org.uk/
http://www.nickelinstitute.org/
http://www.aluminum.org/
www.iom3.org/
www.metalinfo.com/
www.matweb.com/
http://www.recyclemetals.org/about_metal_recycling
https://www.npl.co.uk/
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