ETY 801. Laboratory Practice in Materials IV (Physical Metallurgy)

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**ETY 801**	**SEMESTER**	**8th**
COURSE TITLE	LABORATORY OF MATERIALS IV (PHYSICAL METALLURGY)		

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	5	6
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, skills development
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, users.uoi.gr/metallab/

(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 students, in groups of 4-5, perform a metallurgical act that concerns: development, heat treatment and metallic material evaluation with respect to the microstructure, mechanical properties and corrosion behavior. The metallic materials include steels, aluminum alloys, Ni-Ti alloys, Pb-Sn alloys, copper alloys. The heat treatments include annealing, quenching, aging, austenitizing, pearlitic, bainitic and martensitic transformations. The evaluation techniques include: metallographic preparation and microstructure examination by optical microscopy, mechanical testing (impact, hardness, microhardness), corrosion testing (electrochemical tests).

The main learning objectives of the course are:

- Familiarization of students with the fundamental subjects of Physical Metallurgy (development, heat treatment, microstructural characterization, mechanical properties, corrosion performance).
- Training in metallurgical applications, so that the future alumni acquire some familiarization with the industrial environment in which they might be employed.
- Consolidation of the theoretical knowledge obtained during the theoretical courses of Physical Metallurgy I, Physical Metallurgy II and Corrosion & Protection.
- Practical training
- Preparation for attending the specialized courses of the 9^{th} and 10^{th} semesters (Engineering Alloys, Aluminum Technology, Metal Forming)
- Preparation for carrying out the Diploma Thesis

The main learning outcomes of the course:

- Completion and consolidation of the fundamental principles of Physical Metallurgy that were taught in the theoretical courses of the metallurgical section.
- Practical training in and application of theoretical knowledge to the metallurgical processes, which the young Materials Engineer is going to work with in the production process and quality control (annealing, quenching, aging, austenitizing, martensitic transformations, pearlitic and bainitic transformations, metal forming).
- Training in basic techniques of evaluation of metallic materials {microstructural study by optical microscopy, study of mechanical properties (impact testing, hardness and microhardness testing), study of corrosion behavior (electrochemical testing)}
- Familiarization with basic metallic alloys (steels, Al alloys, Ti-Ni, Pb-Sn, Cu alloys).

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

- Has been familiarized with basic groups of alloys, their heat treatments and properties.
- Has acquired the skills to understand and predict the behavior of a material and select the right material and treatment for a specific application.
- Has completed the basic theoretical knowledge of the classical physical metallurgy.
- Has been familiarized with industrial practices and their logic.
- Is in a position to propose the suitable group and type of metallic materials for a specific application.
- Has been acquainted with the design, realization and completion of a project.
- Has comprehended the relation between theory and practice.

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…*
	…….

- Search for analysis and synthesis of data and information with the use of the necessary technology
- Decision-making
- Team work
- Production of new research ideas
- Production of free, creative and inductive thinking

- Project planning and management
- Respect for the natural environment
- Development of analytical thinking
- Practical training

(3) SYLLABUS

- Laboratory exercises: 1. Microscopy principles and examples of microstructural study by optical microscopy. 2. Metallography and optical microscopy of ferrous alloys, copper alloys, aluminum alloys and tin alloys. 3.Impact testing of ferrous and non-ferrous alloys-Transition from the ductile to the brittle state as a function of temperature. 4. Martensitic transformation of steels. 5. Bainitic transformation of steels. 6. Pearlitic transformation of steels. 7. Tempering of steel and quality control. 9. Strain hardening. 10. Recrystallization annealing. 11. Casting of a binary alloy. 12. Age hardening of Al-4%Cu. 13. Electrochemical corrosion study of steels, aluminum alloys and titanium alloys. 14. Shape memory alloys.

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	Face-to-face through preparatory lectures in a teaching theater and laboratory practice in the two Metallurgy laboratories.
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Power-point, MS Teams, e-course, emails, excel
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*	see table below
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: -Written examination at the end of the semester consisting of exercises, problems and judgement questions -After the end of each laboratory exercise, the students are examined by a short written test (*Questions of short reply)*

Activity	***Semester workload***
Lectures	26 h
Laboratory practice	39 h
Homework (analysis of experimental data, preparation of exercise)	45 h
Non-directed self-study, preparation of final written examination	40
Course total	***150 h***

(5) SUGGESTED BIBLIOGRAPHY

-Suggested books:

1. A. Lekatou, Phase Transformations in Metals, Theodorides Publications, Ioannina 2009,

ISBN-978-960-86109-8-9.
2. A. Lekatou & S. Lekatos, Introduction into Physical Metallurgy, Theodorides Publications, Ioannina, 2009, ISBN-978-960-86109-8-9
3. A. Lekatou, Engineering Alloys, Papasoteriou Pub., ISBN 960-7530-62-4
4. A. Lekatou, Corrosion and protection of metals in simple words, Nemertes Pub., 2014, ISBN 978-960-9951-2-4
5. A. Lekatou, Introduction into the corrosion and protection of metals, Theodorides Pub., 2010, ISBN: 978-960-86109-9-6
6. G.N. Haidemenopoulos, Physical Metallurgy, Tziolas Pub., Thessaloniki, 2007.
7. W. Callister, Science & Technology of Materials, Tziolas Pub., Thessaloniki, 2004.
8. G. Chrysoulakis, D. Pantelis, Science & Technology of Metallic Materials, Papasotiriou Pub., Athens 1996
9. G.K. Triantafyllidis, Physical Metallurgy for the Metallurgical Engineer and the Materials Technologist, Tziolas Pub., Thessaloniki, 2012.
10. J.F. Shackelford, Introduction to Materials Science for Engineers, 5th ed., 2000, NJ, USA, Prentice-Hall.
11. K.G. Budinski, M.K. Budinski, Engineering Materials, Properties and Selection, 7th ed., 2002, USA, Pearson Education
12. P.L. Mangonon, The Principles of Materials Selection for Engineering Design, 1999, NJ, USA, Prentice Hall.
13. D.R. Askeland, The Science and Engineering of Materials, 3rd ed., 1994, Boston, PWS Publishing Co.
14. U.C. Jindal, Atish Mozumder, Material Science and Metallurgy, 2012, Pearson
15. D.A. Brandt, J. C. Warner, Metallurgy Fundamentals, 5th ed., 2009, Goodheart-Wilcox Pub.
16. Sir Alan Cottrell, An Introduction to Metallurgy, 2nd ed., 1997, Routledge Pub.
17. J.W. Martin, Precipitation Hardening, 2nd ed., 1998, Butterworth Heinemann, 0 7506 3885 0.
18. I. Polmear, Light Alloys, 4th Edition - From Traditional Alloys to Nanocrystals, Butterworth-Heinemann, 2005, ISBN 9780750663717
19. HKDH Bhadeshia & RWK Honeycombe, Steels: Microstructure and Properties, Butterworth-Heinemann, 2006, ISBN 9780750680844
20. I. Polmear, Light Alloys, 4th Edition - From Traditional Alloys to Nanocrystals, Butterworth-Heinemann, 2005, ISBN 9780750663717
21. 7 volumes of proceedings of the conferences of the Hellenic Metallurgical Society (2000-2019), most published by Tziolas Pub.

Etc.

-Relevant scientific journals:

22. Materials Science & Engineering
23. Materials & Metallurgical Transactions
24. Journal of Materials Engineering & Performance
25. Ironmaking & Steelmaking
26. Steel research
27. Canadian Metallurgical Quarterly
28. The Journal of The Minerals, Metals & Materials Society (TMS)
29. Journal of Alloys and Compounds
30. Materials & Design
31. Advanced Engineering Materials
32. Metals-MDPI
33. Materials-MDPI
34. 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/
et al.