ETY 903. Technology of Aluminium

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETY 903	**SEMESTER**	**9th**
COURSE TITLE	TECHNOLOGY OF ALUMINUM		

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	3	3
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*	specialized general knowledge
PREREQUISITE COURSES:	-
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	YES
COURSE WEBSITE (URL)	http://ecourse.uoi.gr/course/view.php, http://users.uoi.gr/mgeorgat/aluminium.html

(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*

Learning objectives: The main objective of the course is the training of the students in a group of metallic materials of great engineering significance, that of aluminum alloys. The specific learning objectives of the course are the training, knowledge acquirement and specialization in all the aspects of the integrated technology of aluminum, through:

- An introductory approach to the production technology of aluminum
- A thorough analysis of the physical metallurgy of aluminum and its alloys
- Analysis of the phase transformations of the aluminum systems especially during solidification
- Presentation of the casting technology and the cast products

- Training in critical subjects, such as heat treatments of Al-alloys, metal forming processes (like rolling and extrusion) and corrosion behavior.
- An analytical presentation of new materials based on aluminum, such as aluminum foams, aluminum matrix composites and Al-Li alloys.

The main learning outcomes of the course:

Knowledge acquirement in the integrated metallurgy of aluminum and its alloys, namely knowledge of basic principles of:

- extraction metallurgy,
- physical metallurgy,
- secondary metallurgy,
- heat treatments and metal forming,
- surface treatments,
- corrosion performance
- new aluminum-based materials

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

- comprehend the principles of the production, microstructure and properties of aluminum alloys.
- understand the principles of the fundamental route of aluminum production, namely casting.
- forecast the behavior of an alloy during its application when it is subjected to various burdening conditions based on the data of its composition and microstructure.
- design suitable treatments (thermal, surface etc.) for the attainment of optimal properties before or after the fabrication of an Al alloy.
- evaluate new materials and technologies of aluminum.
- to proceed to the synthesis/production of aluminum alloys.

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
- Team work
- Production of new research ideas
- Production of free, creative and inductive thinking
- Working in an interdisciplinary environment

(3) SYLLABUS

1. INTRODUCTION
   - History
   - Production of alumina (The Bayer Process)
   - Production of aluminum (The Hall Heroult Process)
2. PHYSICAL METALLURGY OF Al ALLOYS
   - Al and its alloys
   - Introduction-properties

Physical metallurgy of Al alloys
Effect of metallurgical factors on the applications
Alloys of special heat treatments
Alloying elements
Metal matrix composites
Surface treatments, anodizing of Al
Light alloys of Al-Li

3. PHASE TRANSFORMATIONS
Introduction
Solidification
Thermodynamics elements
Solidification of pure metals
Growth of a pure solid
Solidification of alloys
Solidification of cast ingots
Super-melting, micro-segregation
Planar growth – Dendritic growth
Solidification defects
Metallurgical measures for the quality assurance of the melt

4. CASTING AND CAST PRODUCTS
DC casting (Direct Chill Casting)
Casting of components
The process of casting
Chemical reactions in the melts
Melt dynamics, Filling system, Feeders
Mold dynamics
Solidification shrinkage
Linear contraction of casts

5. HEAT TREATMENTS OF Al ALLOYS
Precipitation hardening and aging

6. ROLLING – EXTRUSION

7. CORROSION PERFORMANCE - ANODIZATION
The physical surface film of aluminum
Effect of alloying elements and intermetallic compounds
Corrosion performance per alloy group
Corrosion forms and protection methods
Aluminum anodization (Conventional, hard)

8. METAL FOAMS
Introduction
Production methods
Properties (Mechanical, physical, chemical)
Applications

(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, emails
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*	

Activity	*Semester workload*
Lectures	39 h
Student's self-study for periodic exams	19 h
Student's self-study for the	20 h

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*	final exam	
	Course total	***75 h***
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: Two periodical written examinations: Problems and questions Written examination at the end of the semester: Problems and questions For the Erasmus students: Solution of problems + written essay	

(5) SUGGESTED BIBLIOGRAPHY

-Suggested books:

1. A. Lekatou, Corrosion and protection of metals in simple words, Nemertes Pub., 2014, ISBN 978-960-9951-2-4
2. Notes of E. Georgatis
3. Notes of A. Lekatou on Al-aging
4. D. G. Altenpohl, Aluminum: Technology, Applications and Environment: A Profile of a Modern Metal Aluminum from Within, 6th Edition, Wiley, 2010, ISBN: 978-0-87339-406-2
5. J.R. Davis, ASM Specialty Handbook: Aluminum and Aluminum Alloys, ASM Int., 1993, ISBN: 978-0-87170-496-2
6. K. Anderson, J.Weritz, and J. G. Kaufman (eds.), ASM Handbook, Volume 2A: Aluminum Science and Technology, ASM Int., 2018, ISBN: 978-1-62708-158-0
7. I. Polmear, Light Alloys, 4th Edition - From Traditional Alloys to Nanocrystals, Butterworth-Heinemann, 2005, ISBN 9780750663717
8. J.R. Davies, Aluminum and Aluminum Alloys in Alloying: Understanding the Basics, ASM Int. 2001, DOI:10.1361/autb2001, p 351-416
9. J.E. Hatch, Aluminum: Properties and Physical Metallurgy, ASM Int., 1984, ISBN: 978-0-87170-176-3

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-Relevant scientific journals:

1. International ALUMINIUM Journal
2. Aluminium International Today
3. Aluminium Today
4. Materials Science & Engineering
5. Materials & Metallurgical Transactions
6. Journal of Materials Engineering & Performance
7. Advanced Engineering Materials
8. Metals-MDPI
9. Materials-MDPI
10. The Journal of the Minerals, Metals & Materials Society (TMS)
11. Journal of Alloys and Compounds

12. Materials & Design
13. Corrosion Science
14. Corrosion and Materials Degradation
15. Surface & Coatings Technology
16. Construction and Building Materials
17. Surface Engineering
18. Materials and Corrosion
19. Advanced Materials Processing
20. International J. of Cast Metals Research

et al.

-Websites

https://www.aluminum.org/

https://www.aluminum.org/aluminum-advantage/student-educational-resources

www.world-aluminium.org

https://www.european-aluminium.eu/

https://www.britannica.com/science/aluminum

http://www.matweb.com/

https://aluminium.org.au/

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