ETE 707. Corrosion and Protection of Materials

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETE 707	**SEMESTER**	7th
COURSE TITLE	CORROSION AND PROTECTION OF MATERIALS		

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

(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: Corrosion is a phenomenon of great significance, as it causes serious repercussions to the safety, economy, energy consumption, natural resources and environment. Unfortunately, all environments cause corrosion. Within the above framework, this course aims at the comprehension of the corrosion mechanisms and the logic behind the corrosion protection measures. Analytically, the specific learning objectives of the course are the following:

- To manifest the importance of the phenomenon through the introductory lecture on corrosion and its repercussions.
- To acquire knowledge on the electrochemical principles that govern the corrosion processes. Electrochemistry constitutes the base of corrosion science, since corrosion in the vast majority of cases is the result of an electrochemical reaction.
- To train in the corrosion cells and forms, for the following reasons: The analysis of a

corrosion problem requires the evaluation of the damage degree and the identification of the corrosion form, so that appropriate solutions may be proposed. The design of an object with respect to its application in a certain environment should take into account the potential corrosion cells and the induced corrosion forms. Corrosion can be caused by multiple types of corrosion cells and be manifested by multiple corrosion forms. The motivation for corrosion is the electromotive force, namely the electrochemical potential of the galvanic couples in their application environment. The galvanic couples that induce corrosion are called corrosion cells.

- To train in the main corrosion protection methods.
- To evaluate the most common corrosion form, which is the uniform or general corrosion.
- To present the corrosion behavior of five families of alloys, which, due to their high corrosion resistance, are used under mild to aggressive corrosive environments. These alloys are the stainless steels, titanium alloys, nickel alloys, aluminum alloys and copper alloys. These alloys find applications in critical industrial sectors, such as the aerospace industry, the energy industry, the chemical industry, the biomedical industry et al.
- To facilitate the understanding of the mechanisms, through many practical examples and case studies.

The main learning outcomes of the course:

- Theoretical knowledge of electrochemistry and its association with corrosion.
- The student is trained in distinguishing between the different corrosion forms and in proposing proper measures of prevention, right design and treatment.
- The student acquires knowledge about the main corrosion forms of major alloy families, the respective routes of corrosion prevention, protection and management.
- The student acquires knowledge of the effect of various environments on corrosion.

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

- Has acquired theoretical knowledge of those electrochemical elements needed for the comprehension of corrosion phenomena.
- Has become acquainted with many corrosion cases and corrosion forms, as well as their consequences.
- Has been trained in corrosion protection measures.
- Has become familiar with the specific characteristics of corrosion and the specific behavior of main categories of metallic materials in order to be able to select the right material and the right protection method, in relation to the application.
- Is in a position to evaluate the corrosion form and rate.
- Is able to apply suitable design principles for corrosion protection.

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…*
	…….

- Decision-making
- Working independently
- Team work
- Production of new research ideas
- Production of free, creative and inductive thinking

- Respect of and attention to the human safety
- Apprehension of the value of prevention

(3) SYLLABUS

- The importance of corrosion.
- The electrochemical base of corrosion: Electrochemical forecast of corrosion.
- Thermodynamic forecast of corrosion.
- The Nernst equation. pH and corrosion. Corrosion in water. Reference electrodes.
- Corrosion cells and the corrosion forms they cause: Cells between dissimilar metals. Cells between old and new part of the same metal. De-alloying cells. Intergranular cells. Concentration cells. Differential aeration cells. Different conductivity cells. Temperature cells. Stress cells. Stray current cells.
- Corrosion protection cells: Material selection. Prevention of galvanic cell formation. Cathodic protection. Anodic protection. Design against corrosion.
- Corrosion forms: Uniform corrosion. Galvanic corrosion. Intergranular corrosion. Biological corrosion. Pit corrosion. Crevice corrosion. Dew or condensation corrosion. Stress corrosion cracking. Fatigue corrosion. Hydrogen embrittlement. High temperature corrosion.
- Case studies of corrosion.
- Corrosion of engineering alloys

(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*	

Activity	***Semester workload***
Lectures	39 h
Student's study hours	36 h
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: (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 30 exercises (volunteer work, 30% of the total score) For the Erasmus students: Solution of 40 exercises (40% of the total score) + written essay (60% of the total score)

(5) SUGGESTED BIBLIOGRAPHY

-Suggested books:

1. A. Lekatou, Corrosion and protection of metals in simple words, Nimertis Pub., 2014, ISBN 978-960-9951-2-4
2. A. Lekatou, Introduction into the corrosion and protection of metals, Theodorides Pub., 2010, ISBN: 978-960-86109-9-6
3. M.G. Fontana, Corrosion Engineering, Mc Graw Hill, 1986, ISBN 0-07-021463-8
4. J.R. Davis, Corrosion: Understanding the basics, ASM, 2000, ISBN 0-87170-641-5
5. J.C. Scully, The fundamentals of corrosion, Pergamon Press, 1990, ISBN 0-08-037875-7
6. H.H. Uhlig, E.W. Revie, Corrosion and corrosion control, Wiley, 1985, ISBN 0-471-07818-2
7. E.E. Stansbury, R.A. Buchanan, Fundamentals of electrochemical corrosion, ASM, 2000, ISBN 0-87170-676-8
8. M.Schutze, Corrosion and environmental degradation, Wiley, 2000, ISBN 3-527-29505-4
9. P.A. Schweitzer, Corrosion Engineering Handbook, CRC Press, 2007, ISBN 978-0-8493-8243-7, ISBN 978-0-8493-8245-1, ISB 978-0-8493-8247-5
10. Y. Waseda, S. Suzuki, Characterization of Corrosion Products on Steel Surfaces, Springer, 2005, ISBN 10-3-540-35177-9.
11. S.D. Cramer, B.S. Covino, Jr., ASM Handbook Volume 13A: Corrosion: Fundamentals, Testing, and Protection, ASM Int. 2003, ISBN: 978-0-87170-705-5
12. S.D. Cramer, B.S. Covino, Jr., ASM Handbook Volume 13B, Corrosion: Materials, ASM Int. 2005, ISBN: 978-0-87170-707-9

et al.

-Relevant scientific journals:

1. Corrosion Science
2. Materials & Corrosion
3. Apllied Surface Science
4. Corrosion and Materials Degradation
5. International Journal of Corrosion and Scale Inhibition
6. Materials Chemistry and Physics
7. Surface and Coatings Technology
8. Corrosion Science and Engineering
9. Surface Engineering
10. Journal of Electrochemical Society
11. Electrochemica Acta
12. Journal of Solid State Electrochemistry

et al.

-Websites

1. www.corrosion-doctors.org
2. corrosion.ksc.nasa.gov
3. www.corrosionist.com
4. www.icorr.org
5. www.outokumpu.com

et al.