ETE 710 - Materials characterization by X-ray techniques

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	ETE710	**SEMESTER**	7
COURSE TITLE	Materials characterization by X-ray techniques		

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	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
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	

(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 course is an introduction to materials characterization techniques by X-rays.
The objective of the course is to educate the student on the elemental analysis techniques and the structural characterization of materials by X-ray radiation. The nature of the X-rays, X-ray sources and X-ray detection devices are presented. Moreover, energetic electron beams and electron detection systems are discussed. The interaction of X-rays and electrons with matter is explained thoroughly. This allows the understanding of the characterization techniques in the first principals. The student may evaluate by himself the potentiality of each technique and would gain the critical skill to decide about the optimal analytical approach for the problem to be addressed.
The course covers the most important X-ray techniques, like X-ray emission spectroscopy (X-ray fluorescence (XRF), X-ray microfluorescence (μ-XRF), particle-induced X-ray emission (EPMA, PIXE), X-ray absorption spectroscopy (EXAFS, XANES), photoelectron spectroscopy (XPS), radiography and tomography, X-ray diffraction and reflectivity. Examples of these techniques are provided, while the advantages and disadvantages are discussed. A comparison is made to

competitive characterization techniques.

The students are involved in X-ray absorption, fluorescence, and diffraction experiments. They are trained in X-ray equipment for materials characterization. They are involved in data acquisition problems, analyzing experimental data, and interpreting the results. In the context of the analysis, they are trained in the use of simulation programs.

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
- Team work
- Criticism and self-criticism
- Respect for the natural environment
- Production of free, creative and inductive thinking

(3) SYLLABUS

The course includes theoretical lessons and laboratory exercises. The course content is concentrated in the following sections:

1. The nature of X-rays. X-ray production and detection.
2. X-ray interaction with matter.
3. Interaction of electrons with the matter.
4. Atomic orbital atomic structure and ionization. Photonic and non-photonic excitations.
5. X-ray emission spectroscopy: X-ray fluorescence (XRF), electron ionization micro-analysis, X-ray total fluorescence (TXRF), X-ray particle-induced emission (EPMA, PIXE)
6. X-ray absorption spectroscopes (EXAFS, XANES)
7. Photoelectron Spectroscopy (XPS)
8. X-ray radiography. Tomography.
9. X-ray diffraction.
10. X-ray reflectivity.
11. Programs of simulation of experimental methods and analysis of experimental data.
12. Complementary techniques (e.g. Auger spectroscopy, electron diffraction, neutron reflectivity).
13. Laboratory experiments (Beer-Labert law, X-ray emission spectroscopy, X-ray absorption spectroscopy)

(4) TEACHING and LEARNING METHODS - EVALUATION

DELIVERY *Face-to-face, Distance learning, etc.*	In class, lectures	
USE OF INFORMATION AND COMMUNICATIONS TECHNOLOGY *Use of ICT in teaching, laboratory education, communication with students*	Electronic platform e-course	
TEACHING METHODS	***Activity***	***Semester workload***

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*	Lectures	26
	Fieldwork	13
	Homework	13
	Self-study	23
	Course total	75
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) Final oral and written examination (ii) Public representation examination (iii) Laboratory work	

(5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

- Handbook of Practical X-Ray Fluorescence Analysis, Burkhard Beckhoff, Birgit Kanngießer, Norbert Langhoff, Reiner Wedell, Helmut Wolff, Springer ISBN: 978-3-540-28603-5
- Materials Characterization, ASM International, Vol. 10
- Elements of Modern X-Ray Physics, Jens Als-Nielsen, Des McMorrow, John Wiley & Sons, ISBN:0-471-49857
- Elements of X-Ray Diffraction, B.D. Cullity, Addison-Wesley Publishing Company, ISBN:0-201-01230-8

--Related academic journals:

- *X-ray Spectrometry*
- Journal of Analytical Atomic Spectrometry
- Journal of Synchrotron Radiation
- Analytical Chemistry
- Chemical Physics
- Nuclear Instruments and Methods in Physics
- Spectrochimica Acta Part B: Atomic Spectroscopy