ET 814. Fracture Mechanics

COURSE OUTLINE

(1) GENERAL

SCHOOL	SCHOOL OF ENGINEERING		
ACADEMIC UNIT	DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING		
LEVEL OF STUDIES	UNDERGRADUATE		
COURSE CODE	**ET 814**	**SEMESTER**	**8**
COURSE TITLE	FRACTURE MECHANICS		

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 general knowledge
PREREQUISITE COURSES:	NO
LANGUAGE OF INSTRUCTION and EXAMINATIONS:	GREEK
IS THE COURSE OFFERED TO ERASMUS STUDENTS	NO
COURSE WEBSITE (URL)	http://mss-nde.uoi.gr/greek/412%20-%20ETE%20814/index.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*

The course is the basic introductory course in the concepts of fracture mechanics and the fundamental concepts which describe it.

The course topics aim to introduce the student to the concepts of failure of materials with pre-existing cracks and flaws, to understanding the methodologies of calculation of fracture mechanics parameters and design based on fracture mechanics approaches, and to familiarize with the methodology of resolution of problems arising from the presence of cracks and flaws in materials. Upon successful completion of the course the student will:

- Have learnt the subject and scope of Fracture Mechanics, what ductile and brittle fractures are, what is crack propagation and how it can be categorized as stable or unstable.

- Be able to differentiate between the fracture mechanical and mechanics of material approach to material failure.
- Understand stress concentration, know when it occurs and be able to caclulate the stress concentration factor
- Categorize fracture mechanics problems to plane strain and plane stress ones
- Have learnt the fundamental concepts of the energy approach to fracture through the Griffith theory, and to understand the physical meanings of the notions of crack growth resistance R, strain energy release rate G as well as their specific and critical values
- Have learnt the fundamental concepts of the stress intensity approach to fracture, the crack opening modes, stress analysis at the crack tip and the stress intensity factor K_I, K_C and fracture toughness K_{IC}
- Be able to relate fracture toughness to microstructure
- Be able to relate the energy and stress intensity approach to fracture
- Be able to calculate the dimensions of the plastic zone at the crack tip based on the theories of Irwin and Dugdale
- Have understood the crack growth resistance curve (R-curve)
- Have learnt the basic concepts of elasto-plastic fracture mechanics and be able to use the J-integral approach

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
- Project planning and management

(3) SYLLABUS

- Introduction: Fracture, the subject of Fracture Mechanics, Application range, Ductile and brittle fracture, Crack propagation, stable and unstable crack growth, Fracture Mechanics approach to design vs Mechanics of Materials approach, Building Block Approach, Famous Fractures, Stress Concentration
- Stress Concentration factor, effect of radius of curvature of crack, empirical stress concentration factors for known geometries
- Plane conditions: Plane Strain, Plane Stress
- Energy approach to Fracture: Griffith Theory, Crack growth resistance R, strain energy release rate, G, crack growth criteria, specific and critical rates, Griffith theory for plane strain and for elastoplastics
- Stress intensity approach to fracture: Crack opening modes, stress analysis at

the crack tip, Stress intensity factor K_I, geometric factor Y, Plastic Zone, Critical Stress Intensity Factor K_C, Fracture toughness K_{IC}, Fracture toughness and microstructure, designing against fracture, Non-destructive testing, Comparison of energy and stress intensity approaches

- Plastic zone: Irwin zone, Dugdale zone, Plastic zone shape, plastic zones and plane conditions
- Impact testing for fracture mechanics, transition for ductile to brittle fracture
- Fracture mechanics and fatigue
- Special topics: Airy stress function, multiplicity of Y factors, Graphical representation of the crack growth criteria, crack growth resistance curve (R-curve), elastoplastic fracture mechanics, J integral.

(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*	Use of ICT in teaching Web page Communication with students
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	26
Problem solving	13
Self-study	36
Course total	***75h***

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 written examination containing short-answer questions and problem solving

(5) ATTACHED BIBLIOGRAPHY

-Suggested bibliography:

- N. Andrianopoulos, Fracture Mechanics
- D. Broek: The Practical Use of Fracture Mechanics
- R.W. Hertzberg: Deformation and Fracture Mechanics of Engineering Materials

-Related academic journals: