Course unit title:	Introduction to Fracture Mechanics		
Course unit code:	CE445		
Type of course unit:	Technical Elective		
Level of course unit:	Bachelor (1st Cycle)		
Year of study:	4		
Semester when the unit is delivered:	7 (Fall) or 8 (Spring)		
Number of ECTS credits allocated :	6		
Name of lecturer(s):	Dr. Demetris Nicolaides		
Learning outcomes of the course unit:	1. Analyse the concept of categorization of engineering materials: brittle, ductile and quasi-brittle, explain the fundamental concepts of energy-based failure theory, and describe the correlation between cracks and stresses. 2. Explain the limits of applicability of LEFM, describe the Griffith's and Irwin's theories of brittle fracture, explain the correlation between Griffith's and Irwin's failure criteria and analyse the possible modes of failure. 3. Explain the fundamental idea and concept of Stress Intensity Factor (K), describe methods for evaluating SIF, analyse the concept of Critical Stress Intensity Factor or Fracture Toughness (K_{Ic}) and introduce the Barenblatt's cohesive crack model. 4. Explain the tension softening behaviour, describe and explain the mechanisms responsible for the development and size of FPZ, analyse the concept of FPZ of cement-based materials and explain the size-effect on concrete strength, based on the FPZ concept. 5. Explain the limits of applicability of NLFM, analyse the principles of the Fictitious Crack Model (FCM), and describe the concept and methods of calculation of the Specific Fracture Energy (G_F). 6. Describe the concept and methods of calculation of the Characteristic Length (l_{ch}), analyse the principles of the Crack Band Model (CBM) and explain which Fracture parameters are required for the application of the NLFM. 7. Describe how Fracture Mechanics principles are applied in metallic, ceramic and cement-based materials and structures.		
Mode of delivery:	Face-to-face		
Prerequisites:	CE200	Co-requisites:	None
Recommended optional program components:			
Course contents:	**<u>Introduction to Fracture Mechanics:</u>** Analyse the concept of categorization of engineering materials: brittle, ductile and quasi-brittle. Explain the fundamental concepts of Energy-based failure theory and describe the correlation between cracks and stresses. **<u>LEFM: Linear Elastic Fracture Mechanics:</u>** Explain the limits of applicability of LEFM. Describe the Griffith's theory of brittle fracture and the Irwin's theory of brittle fracture and also analyse the possible modes of failure. Provide the fundamental idea and concept of Stress Intensity Factor (*K*) and describe methods for evaluating SIF. Moreover, the concept of the Critical Stress Intensity Factor or Fracture Toughness (K_{Ic}) will be analysed, and explain the correlation between Griffith's and Irwin's failure criteria. Finally, the Barenblatt's cohesive crack model will be introduced. **<u>FPZ: Fracture Process Zone:</u>** Explain the tension softening behaviour of certain materials, describe and explain the mechanisms responsible for the development and the size of FPZ. Analyse the concept of FPZ of cement-based materials and explain the size-effect on concrete strength, based on the FPZ concept. **<u>NLFM: Non-Linear Fracture Mechanics:</u>** Explain the limits of applicability of NLFM. Analyse the principles of the Fictitious Crack Model (FCM) and describe the		

	concept and methods of calculation of the Specific Fracture Energy (G_F). In addition, describe the concept and methods of calculation of the Characteristic Length (l_{ch}) and analyse the principles of the Crack Band Model (CBM). Finally, explain which Fracture parameters are required for the application of the NLFM. **Fracture Mechanics Applications to Engineering Problems:** Describe how Fracture Mechanics principles are applied in metallic, ceramic and cement-based materials and structures.
Recommended and/or required reading:	
Textbooks:	"Fracture Mechanics and Structural Concrete", Karihaloo, Pearson Education, 1995. "Applications of Fracture Mechanics to Concrete, Rock and other Quasi-Brittle materials", Shah, Swartz and Ouyang, John Wiley and Sons, 1995.
References:	"Strength of Materials", Timoshenko, Huntington, N.Y.: R.E. Krieger Pub. Co., 1976.
Planned learning activities and teaching methods:	The course is delivered through theoretical lectures in class. The lectures present to the student the course content and allow for questions. Part of the material is presented using visual aids. The aim is to familiarize the student with the different and faster pace of presentation and also allow the instructor to present related material (photographs, videos, etc.). The learning process is enhanced with the requirement from the student to solve relevant examples. Besides from the notes taken by students in class, all of the course material is available through the class website and also through e-learning platform. Finally the instructor is available to students during office hours or by appointment in order to provide any necessary tutoring.
Assessment methods and criteria:	• Coursework 50% • Final Exam 50%
Language of instruction:	English
Work placement(s):	No