Course unit title:	Strengthening and Repairing of Structures		
Course unit code:	CE 440		
Type of course unit:	Technical Elective		
Level of course unit:	Bachelor		
Year of study:	4		
Semester when the unit is delivered:	7 (Fall)		
Number of ECTS credits allocated :	6		
Name of lecturer(s):	Dr Petros Christou		
Learning outcomes of the course unit:	1. Describe the principles and concepts of modern design codes appropriate for different repair or strengthening methods. 2. Identify and distinguish between available materials and methods for repair and strengthening and select the appropriate material/method. 3. Apply, interpret & use code provisions for the determination of the appropriate amount of strengthening materials. 4. Assess the structural capacity of the structure after the application of the strengthening mechanism. 5. Analyse and design beams, columns, and connections and determine the capacity of the member after repairing. 6. Propose alternative repair schemes for the same structure. 7. Evaluate and defend the selected repair scheme for a specific structure.		
Mode of delivery:	Face-to-face		
Prerequisites:	CE 310	Co-requisites:	None
Recommended optional program components:	None		
Course contents:	• **Introduction:** Identify sources of structural damage to concrete, steel, wood and masonry structural elements and structures. Identify methods for accessing the damage level to various structures. List methods of repairs for various types of damages. Identify codes and specifications relating to repair and strengthening/retrofitting of structures. • **Materials, Material Properties and Manufacturing:** List materials used for repair or retrofitting for various structures. Identify and list the properties of repair/retrofitting materials and how these properties are effective in repairing and or strengthening of a structure. Identify appropriateness of a material as a repair material or strengthening material for the different types of structures and damages. Identify manufacturing techniques for repair materials such as Fiber Reinforced Polymer (FRP) composites. Identify the methods of manufacturing of FRP composites and identify the advantages of each technique. Identify the effect of the manufacturing method on the properties of the FRP composite and its durability. • **Methods and Techniques of Repair:** Identify methods or techniques for repair retrofitting of structural elements or structures. Differentiate between aesthetic repair and structural repairs and strengthening. List methods of repair for cracks (injections), concrete spalling, reinforcement corrosion etc. Identify protection and preventing measures for limiting or minimizing further damage. List structural repair and strengthening methods such as steel cages, FRP strengthening etc. Identify the advantages and disadvantages of each repair strengthening method. • **Repair and Strengthening Codes:** Identify available codes and standards for repair and retrofitting of structures. Understand the principles of repair and strengthening design codes. Identify differences between European and US		

	codes and Standards. • **Repair Strengthening Design with FRP Composites (EC8):** Analyse and design individual member repair or strengthening using FRP composites according to Eurocode 8 (EC8) part 3 requirements. Design and analyse shear strengthening for beams or columns using FRP wraps according to EC8. Design and analyse flexural strengthening of beams, slabs and columns using FRP wraps according to EC8. • **Repair Strengthening Design with FRP Composites (ACI440):** Analyse and design individual member repair or strengthening using FRP composites according to American Concrete Institute (ACI 440) requirements. Design and analyse shear strengthening for beams or columns using FRP wraps according to ACI440. Design and analyse flexural strengthening of beams, slabs and columns using FRP wraps according to ACI440.
Recommended and/or required reading:	
Textbooks:	1. Gangarao H. V. S., Taly N. and Vijay P. V. (2007), "**Reinforced Concrete Design with FRP Composites**", Taylor and Francis, 382 pp. 2. Eurocode 8 : **Design of structures for earthquake resistance - Part 3: Assessment and retrofitting of buildings** 3. ACI 440.2R: **Guide for the Design and Construction of Externally Bonded FRP Systems for Strengthening Concrete Structures**
References:	J. G. Teng, J. F. Chen, S. T. Smith, and L. Lam (2001), "**FRP: Strengthened RC Structures**", Wiley and Sons, 268 pp.
Planned learning activities and teaching methods:	The course is delivered to the students by means of lectures. The lecturer presents to the student the course content and allows for questions. The material is presented using computer presentations incorporating photos / diagrams. Presentation Handouts, homework assignments, and additional material such as relevant magazine articles are made available to students at any time on the e-learning Moodle platform. The learning process is enhanced with the requirement from the student to submit assessments.
Assessment methods and criteria:	• Course work: 50% • Final Exam: 50%
Language of instruction:	English
Work placement(s):	No