CES550 - Prestressed Concrete Design

Course Title	Prestressed Concrete Design				
Course Code	CES550				
Course Type	Elective				
Level	MSc (Level 2)				
Year / Semester	2nd / 3rd				
Teacher's Name	Antonis Michael				
ECTS	7	Lectures / week	3	Laboratories / week	
Course Purpose	This course deals with the subject of concrete structures and in particular structures constructed using the concept of prestress. The aim of the course is to introduce the students to the concept of prestress in concrete structures. Students will be able to identify the advantages in building with prestressed concrete and evaluate when this type of construction is suitable and economically viable. With the completion of this course students will be able to perform their own research on particular aspects or practical applications, find design information (loads, analysis approaches etc.) on their own apply code requirements and analyze/design prestressed beams and slabs and produce complete design drawings of their design.				
Learning Outcomes	1. Define the principle of prestressed concrete and its applications and list methods of prestressing and appropriate design codes. 2. Analyse the stress condition caused by prestressing and calculate imposed stresses. 3. Associate different systems with the construction of specific prestressed structures. 4. Apply appropriate code provisions for the design of prestressed concrete beams and slabs. 5. Create detailed construction drawings for prestressed members. 6. Explain how size standardization and mass production influences the economic viability of prestressed concrete.				
Prerequisites		Corequisites			
Course Content	**Introduction:** Define prestress concrete concept. Identify key historical points in the development of modern prestress concrete structures. Identify and list codes and specifications for prestressed concrete. Identify and define the basic principles of prestressed concrete. Identify the material properties of pre-stressing steels such the stress-strain behaviour. Identify the material properties of concrete for prestressed construction (strength, creep, shrinkgage, etc.). **Prestressing and Post-Tensioning Systems:** List and discuss prestressing and postensioning systems. Discuss and list basic differences. Identify the				

	basic methods for calculating stresses in prestress concrete members (stress superposition, C-line method etc.). Calculate stresses at release of prestress and after prestress losses. Identify stress limitations based on code requirements for prestress members. Identify and list losses of prestress in pre-tensioning and post tensioning systems. Identify code provisions relating to prestress losses. Calculate prestress losses due to elastic shortening of concrete, steel relaxation, friction, creep and shrinkage etc. **Analysis of Sections for Flexure:** Present the method of transformed section for determining the exact theoretical solution for both pre-tensioned and post-tensioned concrete members. Calculate stresses for both pre-tensioned and post-tensioned concrete members using the exact theoretical solution and compare with the approximate solution. Identify the development of stresses in steel due to loads in prestress concrete and compare with stresses in steel for reinforced concrete. **Cracking Moment in Prestress Concrete Members:** Identify and list design assumptions. Identify code provisions for calculating the flexural tensile strength of concrete in the extreme fiber. Identify and explain kern points and how they are associated with the location of the center of compression C. Calculate cracking moment for prestressing concrete sections. **Ultimate Moment Capacity:** Present and discuss typical loading history and stress distribution across the depth for typical prestress concrete members. Identify typical load displacement history for typical prestress concrete members. Identify conditions for using the C-line method to determine the ultimate moment capacity of prestressed sections with bonded tendons. Identify and list modes of failure for prestress concrete members. Identify code provision relating to the design of prestressed members (Ultimate moment capacity). Identify code provisions for the termination of prestressing steel and concrete material properties at the ultimate limit state. Calculate ultimate moment capacity of rectangular and tee sections according to code provisions for sections with regular and prestress reinforcement. **Shear Resistance:** Shear in beams and the effect of prestress. Web reinforcement for shear resistance. Design strength of beams without and with shear reinforcement. **Moment Curvature Analysis:** Define the term curvature and how it relates to ductility of structural members. Identify and list the assumptions made for the performance of a moment curvature analysis. Identify stress strain relationship of steel and concrete for the analysis. Identify the analysis procedure and its stages (prior to cracking and after cracking). Calculate and plot the moment curvature response of rectangular sections.
Teaching Methodology	The course is presented through theoretical lectures in class and experimental exercises in the laboratory. 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 (drawings, graphs, photographs etc.) that would otherwise be very difficult to do. As part of the learning process students are required to solve course related problem exercises. These include self-evaluation exercises which are solved in class and are not graded. Exercises are also given as

	homework assignments which are part of the student course assessment. Students are expected to take notes in class during lectures; however, all course material is available to students through the class website on the e-Learning platform. Students are assigned a design project which requires them to collect data for the design a prestressed structure on their own. These forces students to research the specific subject, find imposed loads, model the structure, analyze it and come up with a design that meets code requirements. The students are required to present their work in class and submit an electronic report showing all of their work. Finally the instructor will be available to students during office hours or by appointment in order to provide any necessary tutoring.
Bibliography	**Textbooks:** 1. "Design of Prestressed Concrete to Eurocode 2: Second Edition", Raymond Ian Gilbert, Neil Colin Mickleborough and Gianluca Ranzi, 2017, CRC Press Taylor & Francis, ISBN-13: 978-1-4665-7310-9 (Hardback), ISBN -13: 978-1-3153-8952-3 (eBook) 2. CYS EN1992: Design of Concrete Structures – Part 1-1: General rules and rules for buildings. **References:** "Prestressed Concrete: A Fundamental Approach: 5th edition", Edward G. Nawy, 2009, Prentice Hall, 984 pp.
Assessment	Student assessment is based on homework assignments, an individual project, midterm exams and a final exam. The assessment criteria are provided with each assignment, project and exam for the specific course. The weights for each assessment method are as follows: Midterm Exams 20% Homework Assignments 10% Design Project 20% Final Exam (Comprehensive) 50%
Language	English