| COURSE INFORMATON | | | | | |
|---|---|---|---|---|---|
| **Course Title** | *Code* | *Semester* | *L+P+L Hour* | *Credits* | *ECTS* |
| **MECHANICS OF REINFORCED CONCRETE** | CE 520 | - | 3+0+0 | 3 | 10 |

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| **Prerequisites** | |

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| **Language of Instruction** | English |
| **Course Level** | Master's Degree (Second Cycle Programmes) |
| **Course Type** | Departmental Elective |
| **Course Coordinator** | - |
| **Instructors** | Assist. Prof. Dr. Almıla Uzel |
| **Assistants** | - |
| **Goals** | Analysis, design and behaviour modelling of reinforced concrete structures are introduced. Analysis and design of reinforced concrete members beyond sectional models are discussed. |
| **Content** | Mechanical properties of concrete and reinforcement; constitutive relations; linear-elastic models; nonlinear-elastic models; elastic-plastic models; and limit analysis theorems; compression field model is discussed along with its implementation and application in nonlinear finite element analyses and strut-and-tie modeling. |

| **Course Learning Outcomes** | **Program Learning Outcomes** | **Teaching Methods** | **Assessment Methods** |
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| 1) Knowledge on characteristics of reinforced concrete materials. | 1,2,5 | 1,2 | A, B |
| 2) Knowledge on the structural behavior of reinforced concrete under flexural, axial and shear effects. | 1,2,5 | 1,2 | A, B |
| 3) Knowledge on the nonlinear characteristics of reinforced concrete members. | 1,2,5 | 1,2 | A, B |
| 4) Theoretical modeling of reinforced concrete behavior under various actions. | 1,2,5,7 | 1,2,3 | A, B, C |
| 5) Use of computer programs for analysis of reinforced concrete behavior. | 1,2,5,7 | 1,2,3 | A, B, C |

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| **Teaching Methods:** | 1: Lecture, 2: Question-Answer, 3: Project |
| **Assessment Methods:** | A: Written Exam, B:Homework, C: Project Evaluation |

| COURSE CONTENT | | |
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| **Week** | **Topics** | **Study Materials** |
| 1 | Introduction, why non-linear analysis, material properties of concrete and steel. | Lecture Notes and Textbook |
| 2 | Linear Elastic Models/ Non-linear Elasticity Models | Lecture Notes and Textbook |
| 3 | Constitutive Models and Failure Criteria | Lecture Notes and Textbook |
| 4 | Limit Analysis using Plasticity- Lower Bound and Upper Bound Theories | Lecture Notes and Textbook |
| 5 | Behavior of Members Subjected to Shear, History of research on concrete under shear. | Lecture Notes and Textbook |
| 6 | Compression Field Theory and Modified Compression Field Theory (MCFT). | Lecture Notes and Textbook |
| 7 | Mechanisms affecting shear behavior of members and implementation of these mechanisms into MCFT. | Lecture Notes and Textbook |
| 8 | Determination of member shear capacity using MCFT procedures. | Lecture Notes and Textbook |
| 9 | Midterm Exam | Lecture Notes and Textbook |
| 10 | Design using MCFT, code implementation of MCFT, Simplified Modified Compression Field Theory (SMCFT), shear provisions of Canadian Code (CSA A23.3-14) and AASHTO codes. | Lecture Notes and Textbook |
| 11 | Design of Disturbed Regions, B- and D- regions, Strut and Tie models, strength of struts, ties and nodal zones, deep beams, corbels | Lecture Notes and Textbook |
| 12 | Code approaches to strut-and-tie modeling of Reinforced Concrete and Prestressed Concrete Members | Lecture Notes and Textbook |
| 13 | Nonlinear finite element methods for the analysis and design of disturbed regions | Lecture Notes and Textbook |
| 14 | Nonlinear finite element analysis of shear critical members. | Lecture Notes and Textbook |
| 15 | Work on term project | Lecture Notes and Textbook |

| RECOMMENDED SOURCES | |
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| **Lecture Notes** | Notes prepared by the instructor, published research papers |
| **Textbook** | **Reinforced Concrete Mechanics and Design:**<br>Authors: J.K. Wight, J.G. MacGregor, Prentice Hall, 2008. |
| | **Non-linear Mechanics of Reinforced Concrete:**<br>Authors: K. Maekawa, H. Okamura, A. Pimanmas, CRC Press, 2003. |

| MATERIAL SHARING | |
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| **Documents** | Lecture notes delivered to the students |
| **Assignments** | Homeworks are returned to students after they are graded |
| **Exams** | Exams questions are solved if demanded |

| ASSESSMENT | | |
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| **IN-TERM STUDIES** | **NUMBER** | **PERCENTAGE** |
| Mid-terms | 1 | 50 |
| Quizzes | - | - |
| Assignment | 6 | 20 |
| Term Project | 1 | 30 |
| **Total** | | **100** |
| **CONTRIBUTION OF FINAL EXAMINATION TO OVERALL GRADE** | | 40 |
| **CONTRIBUTION OF IN-TERM STUDIES TO OVERALL GRADE** | | 60 |
| **Total** | | **100** |

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| **COURSE CATEGORY** | Expertise/Field Courses |

**COURSE'S CONTRIBUTION TO PROGRAM**

| No | Program Learning Outcomes | Contribution | | | | |
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| | | 1 | 2 | 3 | 4 | 5 |
| 1 | Attains knowledge through wide and in-depth investigations his/her field and surveys, evaluates, interprets, and applies the knowledge thus acquired. | | | | x | |
| 2 | Has a critical and comprehensive knowledge of contemporary engineering techniques and methods of application. | | | | x | |
| 3 | By using unfamiliar, ambiguous, or incompletely defined data, completes and utilizes the required knowledge by scientific methods; is able to fuse and make use of knowledge from different disciplines. | | | | | |
| 4 | Has the awareness of new and emerging technologies in his/her branch of engineering profession, studies and learns these when needed. | | | | | |
| 5 | Defines and formulates problems in his/her branch of engineering, develops methods of solution, and applies innovative methods of solution. | | | | x | |
| 6 | Devises new and/or original ideas and methods; designs complex systems and processes and proposes innovative/alternative solutions for their design. | | | | | |
| 7 | Has the ability to design and conduct theoretical, experimental, and model-based investigations; is able to use judgment to solve complex problems | | | | x | |

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| | that may be faced in this process. | | | | | |
| 8 | Functions effectively as a member or as a leader in teams that may be interdisciplinary, devises approaches of solving complex situations, can work independently and can assume responsibility. | | | | | |
| 9 | Has the oral and written communication skills in one foreign language at the B2 general level of European Language Portfolio. | | | | | |
| 10 | Can present the progress and the results of his investigations clearly and systematically in national or international contexts both orally and in writing. | | | | | |
| 11 | Knows social, environmental, health, safety, and legal dimensions of engineering applications as well as project management and business practices; and is aware of the limitations and the responsibilities these impose on engineering practices. | | | | | |
| 12 | Commits to social, scientific, and professional ethics during data acquisition, interpretation, and publication as well as in all professional activities | | | | | |

| ECTS ALLOCATED BASED ON STUDENT WORKLOAD BY THE COURSE DESCRIPTION | | | |
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| Activities | Quantity | Duration (Hour) | Total Workload (Hour) |
| Course Duration (Excluding the exam weeks: 14x Total course hours) | 14 | 3 | 42 |
| Hours for off-the-classroom study (Pre-study, practice) | 14 | 2 | 28 |
| Midterm examination | 1 | 3 | 10 |
| Homework | 6 | 15 | 90 |
| Project | 1 | 50 | 50 |
| Final examination | 1 | 2 | 20 |
| **Total Work Load** | | | 240 |
| **Total Work Load / 25 (h)** | | | 10 |
| **ECTS Credit of the Course** | | | 10 |