Cracow University of Technology

Course syllabus

binding for the doctoral students of the CUT Doctoral School commencing their studies in the academic year 2022/2023

Information on the course

Name of the course in Polish	Mechanika Betonu i Żelbetu
Name of the course in English	Concrete and Reinforced Concrete (RC) Mechanics
Number of the ECTS points	1
Language of instruction	Polish/English
Category of the course	Choosable
Field of education	Engineering and Technology
Discipline of education	Civil Engineering and Transport
Person responsible for the course Contact	Andrzej Winnicki andrzej.winnicki@pk.edu.pl

Type of course, number of hours in the study programme curriculum

Semester	Credit type (G / NG)*	Lecture	Practical classes	Laboratory	Computer Lab	Project Class	Seminar
2, 3, 4, 5	G	15	0	0	0	0	0

*G – graded credit, NG – non-graded credit

Course objectives

Code	Objective description
Objective 1	Learning the basics of concrete and reinforced concrete mechanics
Objective 2	Learning the material models used in the nonlinear analysis of concrete elements and structures
Objective 3	Acquiring the ability to select the appropriate material models and their parameters for non-linear analysis of concrete elements and structures

Learning Outcomes

Code	Description of the learning outcome adjusted to the specific characteristics of the discipline	Learning outcome symbol in the CUT SD	Methods of verification
OUTCOMES RELATED TO KNOWLEDGE			
EUW1	A PhD student knows and understands the properties of concrete in complex loading conditions	E_W01, E_W02	Involvement in class activities, a written assignment
EUW2	A PhD student knows and understands basic material models for concrete, knows and understands the localization phenomenon for quasi-brittle materials	E_W01, E_W02	Involvement in class activities, a written assignment

EUW3	A PhD student knows the rules of numerical calculations for concrete elements and structures	E_W01, E_W02	Involvement in class activities, a written assignment
OUTCOMES RELATED TO SKILLS			
EUU1	A PhD student is able to select the appropriate values of input parameters for concrete material models	E_U01	Involvement in class activities, a written assignment
EUU2	A PhD student is able to assess the suitability of material models available in professional FEM programs (DIANA, Atena, Abaqus) for the calculation of concrete elements and structures	E_U01	Involvement in class activities, a written assignment
OUTCOMES RELATED TO SOCIAL COMPETENCES			
EUK1	A PhD student is able to critically evaluate the methodology of numerical calculations of concrete elements and structures presented in the scientific literature	E_K01, E_K03	Involvement in class activities, a written assignment
EUK2	A PhD student is aware of the importance of the mechanics of concrete and reinforced concrete in solving practical problems in civil engineering	E_K01, E_K03	Involvement in class activities, a written assignment

Course outline

No.	Contents	Learning outcomes for the course	No. of hours
LECTURE			
W1	Mechanical properties of concrete in complex loading conditions (experimental knowledge, experiments)	EUW1, EUU1, EUK2	3
W2	Reinforced steel and steel adhesion to concrete, reinforced concrete as a composite (experimental knowledge, experiments)	EUW1, EUU1, EUK2	1
W3	Constitutive modelling of concrete: plasticity theory for materials with weakening, plasticity surfaces for concrete	EUW2, EUW3 EUU1, EUU2 EUK1, EUK2	2
W4	Plasticity theory for weakened materials - algorithmic problems	EUW2, EUW3 EUU1, EUU2 EUK1, EUK2	2
W5	Continuous damage mechanics, "concrete damaged plasticity (CDP)" models, fuzzy scratch models with fixed and changing directions, discrete scratch models	EUW2, EUW3 EUU1, EUU2 EUK1, EUK2	3
W6	The issue of location - objectivity of the results of numerical simulations	EUW2, EUW3 EUU1, EUU2 EUK1, EUK2	2
W7	Reinforcement modelling, examples of numerical calculations for concrete elements and structures	EUW2, EUW3 EUU1, EUU2 EUK1, EUK2	2

The ECTS points statement

WORKING HOURS SETTLEMENT

Type of activity	Average number of hours (45 min.) dedicated to the completion of an activity type
SCHEDULED CONTACT HOURS WITH AN ACADEMIC TEACHER	
Hours allotted in the syllabus	15
Consultations	2
Examination / course credit assignment	1
HOURS WITHOUT THE PARTICIPATION OF AN ACADEMIC TEACHER	
Independent study of the course contents	6
Preparation of a paper, report, project, presentation, discussion	6
ECTS POINTS STATEMENT	
Total number of hours	30
The ECTS points number	1

Preliminary requirements

No.	Requirements
1	General knowledge of the mechanics of a solid, including the basics of the theory of elasticity and plasticity is required

Course credit assignment conditions / method of the final grade calculation

No.	Description
COURSE CREDIT ASSIGNMENT CONDITIONS	
1	75% attendance in class.
2	Credit for oral presentation of a self-prepared written work on a selected material model for concrete or numerical modelling of a concrete structure
METHOD OF THE FINAL GRADE CALCULATION	
Assessment of the completion of the presented work, taking into account the attendance	

Additional information

Not specified

The course reading list

1	R. de Borst, M. Crisfield, J. Remmers, C. Verhoosel, *Non-linear FE Analysis of Solids and Structures,* Chichester, UK, John Wiley and Sons, 2012
2	fib (Ed.), *Code-type models for concrete behaviour. Background of MC2010*, fib Bulletin No 70, 2013
3	H. Mang, G. Hofstetter, *Computational Mechanics of Reinforced Concrete Structures*, Braunschweig, Wiesbaden, Germany, Vieweg Verlag, 1995
4	W.F. Chen, *Plasticity in Reinforced Concrete*, New York, USA, McGraw-Hill, 1982
5	fib (Ed.), *Practitioners guide to finite element modelling of RC structures*, fib Bulletin No 45, 2008
6	J. Pamin, A. Winnicki, *IX Obliczeniowe modele materiałów: sprężystość, plastyczność, zarysowanie*, *X Obliczeniowe modele materiałów: uszkodzenie, lokalizacja odkształceń, przykłady*, Praca zbiorowa: Współczesna mechanika konstrukcji w projektowaniu inżynierskim, A. Garstecki, W. Gilewski, Z. Pozorski (Eds), Studia z zakresu inżynierii Nr 92, KILiW PAN, Warszawa, 2015

7	K. Maekawa, A. Pimanmas, H. Okamura, *Non-Linear Mechanics of Reinforced Concrete,* Boca Raton, USA, CRC Press, 2003
8	U. Häussler-Combe, *Computational Methods for Reinforced Concrete Structures,* Berlin, Germany, Ernst und Sohn, 2014
9	M.P. Nielsen, L.C. Hoang, *Limit Analysis and Concrete Plasticity*, Boca Raton, USA, CRC Press, 2010
10	Magazines: *Engineering Structures, Computers & Concrete, Materials and Structures, ACI Materials Journal, ACI Structural Journal, Structural Concrete, Magazine of Concrete Research, ASCE Journal of Engineering Mechanics, Int. Journal of Solids & Structures, Int. Journal of Plasticity, Engineering Fracture Mechanics, Journal of Advanced Concrete Technology (JCI), Int. Journal of Damage Mechanics, Mechanics of Materials, MDPI Materials,* etc
11	Conference materials, in particular the series: *Conferences on Computational Modelling of Concrete and Concrete Structures (EURO-C), Conferences on Fracture Mechanics for Concrete and Concrete Structures (FraMCoS)*