SYLLABUS

Name: ***Advanced Modelling of Structural Materials (BudAB>SM2ADMSMA19)***
Name in Polish:
Name in English: ***Advanced Modelling of Structural Materials***

Information on course:

Course offered by department: Faculty of Civil Engineering
Course for department: Silesian University of Technology

Default type of course examination report:

ZAL

Language:

English

Course homepage:

https://platforma.polsl.pl/rb/course/view.php?id=296

Short description:

The aims of the course are as follows:
Understanding of material description used in building structures design and analysis. Extended classification and recognition of problems in material modelling. Simplifications applied in material modelling. Material models from 1D to 3D problems. Phenomena influencing material modelling. Plastic behaviour and its influence on ultimate resistance of members and structures.
Practical abilities and understanding material modeling applied in computer applications.

Description:

LECTURES - 8 hours
Course contains:
Review of material model types. Material behaviour and its description with regard to analysed problem – from simple models used in design to complex models for research and analysis.
Simple material models used in engineering problems. One dimensional models for dimensioning RC sections. Stiffness of RC sections/ segments with regard to material behaviour (cracking of concrete in tension, softening of concrete in compression, plastic deformations of steel etc.). Relation between flexural stiffnes and curvature. Deflection control of RC members considering stiffness reduction.Use Finite Difference Method for calculations of the member deflection.
Subsoil modeling. Interaction between structure and the subsoil. Consideration of complex material behaviour in engineering software. Softening and hardening. Kinematic and isotropic hardening. Bauschinger effect. Failure and plastic criteria overview. Flow rules applied in analysis. Comparison of linear and nonlinear (physically and geometrically) analysis. Shortcomings related to simplified methods used in design. Plastic reserve. Redistribution of internal forces as a result of plastic properties of applied material. Stress, strain and energy as a criterion of ultimate state. Step-by-step description of analysis performed with use of FEM. Modelling of cracks –simplification used in modelling. Macro models and phenomena in micro scale. Scale effect. Damage models. Nominal and true stress. Multiaxial material behaviour. Necessity of generalisation of plastic behaviour required for 3D analysis. Forms of stress and strain representation. Invariants, axiatoric and deviatoric components of stress and strain states. Testing material properties in complex spatial stress states.

LABORATORIES - 10 hours
Engineering problems considering nonlinear material behaviour. Analysis of the selected mechanical problems solved with used of applications elaborated by lecturer (foundation - subsoil interaction, piles behaviour under horizontal loads, design of RC sections with use of nonlinear material models).

SEMINARS - 12 hours
Students elaborate one topic selected from the list. One presentation during seminar is presented.

Bibliography:

[1] Chen Wai-Fah: Constitutive Equations for Engineering Materials, Volume 2, Plasticity and Modeling.
[2] Chen W.F., Zhang H.: Structural Plasticity. Theory, problems and CAE software.
[3] Zienkiewicz O.C., Taylor R.L.: The Finite Element Method
[4] Wandzik G.: Advanced modelling of structural materials - teaching materials

Learning outcomes:

KNOWLEDGE
(1) Understanding of simplification in material modelling used for design purposes - [course effect K2A_W04]
(2) Methods of consideration of material nonlinearities in FEM and FDM - [course effect K2A_W04]
(3) Understanding methods of implementation of phenomena related to material behaviour influencing ultimate resistance of sections/ members/structures - [course effect K2A_W04]

SKILLS
(4) Skill to perform and understand nonlinear static analysis considering physical and geometrical nonlinearities [course effect K2A_U04]
(5) Ability to select material model appropriate for the analysed problem
[course effect K2A_U05]
(6) Ability to critical evaluation of the numerical analysis results of structures modelled with linear and nonlinear material models - [course effect K2A_U06]

Assessment methods and assessment criteria:

PRELIMINARY REQUIREMENTS:
Strength of materials.

REQUIREMENTS:
(1) Active attendance in laboratories.
(2) Presentation during seminar.
(3) Passing the colloquium covers topics discussed during lectures and laboratories (due to very small group assesment can be substituted by discussions during lectures and seminars)

FINAL ASSESSMENT:

50% (colloquium), 30% (laboratory), 20% (seminar)

POSSIBILITY OF TRANSFERRING GRADES:
To transfer partial grades, students should contact the lecturer within the first two weeks of the semester.

The syllabus is valid from the summer semester of the 2025/2026 academic year, and its content is not subject to change during the semester.

Element of course groups in various terms:

Course group description	First term	Last term
missing group description in English (BudAB-S2-2019-sem2)	2020/2021-L	

Course credits in various terms:

<without a specific program>

Type of credits	Number	First term	Last term
European Credit Transfer System (ECTS)	2	2020/2021-Z	