POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Computer aided design [S1Bud1>KWP]

Course

Field of study Civil Engineering	Year/Semester 2/4
Area of study (specialization) –	Profile of study general academic
Level of study first-cycle	Course offered in Polish
Form of study full-time	Requirements compulsory

Number of hours

Lecture 30	Laboratory classes 30	Other (e.g. online) 0
Tutorials 0	Projects/seminars 0	

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

The student has a basic knowledge of physics, strength of materials and structural mechanics. The student has knowledge of mathematics, including matrix and vector operations, solving systems of equations, fundamentals of solving differential equations and integration. The student has basic knowledge of computer science and programming. The student is able to use computer equipment. The student is able to use available sources of information, interpret them and draw conclusions. The student is able to solve basic engineering problems. The student is able to work in a team.

Course objective

Introduction to the finite element method as a tool for modelling and strength analysis of engineering structures with particular emphasis on problem formulation and accuracy assessment. Presentation of the basic assumptions, limitations and algorithm of the method and derivation of equations describing selected finite elements. Discuss selected structural modelling issues in construction. Acquire the ability to solve typical problems with publicly available computer tools (e.g. spreadsheets, SciLab+CALFEM), but also with specialised software based on the finite element method.

Course-related learning outcomes

Knowledge:
-have knowledge in the fields of mathematics, physics, chemistry, biology and other fields of sciencen suitable to formulate and solve problems concerning sustainable building engineering (civil engineering, environmental engineering and architecture).
-have detailed knowledge in theoretical mechanics, knowledge of materials' strength, and general rules of shaping structures.
-have basic knowledge of operation algorithms of selected software (including the usage of BIM technology), supporting the calculation and design of constructions, construction work organisation, cost estimation, technical fitting of buildings; basic knowledge of operation algorithms of software dedicated for evaluation and design of energy-saving buildings.

Skills:
-are able to obtain information from literature, databases and other properly selected information sources; can integrate the obtained information, interpret and evaluate it, as well as draw conclusions, formulate, discuss and justify opinions.
-are able to use advanced information and communication technologies (ICT) appropriate to perform typical engineering tasks.
-are able to correctly utilise numerical, analytical, simulation, and experimental methods, to identify and solve problems in sustainable building engineering; to obtain and verify the results.
-can utilize selected software supporting design decisions in sustainable building engineering, including programs based on the BIM technology; are able to critically evaluate the obtained results of numerical analysis of building unit.

Social competences:
-are able to adapt to new and changing circumstances, can define priorities for performing tasks defined by themselves and other people, acting in the public interest and with regard to the purposes of sustainable development.
-take responsibility for the accuracy and reliability of working results and their interpretation.
-are able to critically evaluate the results of their own work..

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

The basis of assessment is a colloquium. It may be supplemented by additional tests and assignments made during the semester and participation and activity in laboratory classes.

Assessment criterion: 5,0 (>90%), 4.5 (>80%), 4.0 (>70%), 3.5 (>60%), 3.0 (>50%), 2,0 (<50%).

Programme content

Introduction to the finite element method as a tool for modelling and strength analysis of engineering structures. Presentation of the basic assumptions, the algorithm of the method and derivation of equations describing selected finite elements. Discussion of selected structural modelling issues in construction.

Course topics

The lecture programme covers the following topics:
* Introduction to the finite element method (FEM).
* The problem of the boundary problem of linear elastic theory.
* Assumptions and derivation of equations describing:
 - 1D and 2D lattice element,
 - transformation of the stiffness matrix of a 2D lattice element,
 - 2D beam element,
 - transformation of the stiffness matrix of a 2D beam element,
 - reduction of spanwise load to nodal loads,
 - [optional] 3D beam element,
 - geometric matrix for 2D beam element,
 - [optional] triangular finite element CST and LST
* Discussion of the FEM algorithm.
* Presentation of the FEM algorithm with examples:

- one-dimensional lattice system,
- flat truss,
- single and multi-span beam,
- flat frame,
- [optional] spatial frame,
- non-linear analysis of frame system (geometric matrix),
- initial stability of a frame system,
- [optional] plane stress problem.

The laboratory programme covers the following topics:
* Recall and practice of the SciLab environment in terms of:
- use of batch mode (SciNote) and interaction mode (console),
- iterative and conditional instructions,
- matrix and vector operations,
- solving systems of linear equations,
- defining, importing and calling functions.
* Introduction to the CALFEM calculation system.
* Analysis of building structures using CALFEM:
- 1D and 2D lattice systems,
- beams and frame systems,
- mixed systems using beam and lattice elements,
- frame systems including geometric matrix,
- initial stability of frame systems,
- [optional] plane strain/strain state.
* Modelling of engineering structures (examples):
- beam with linearly varying cross-section,
- hinges,
- settlement and susceptibility of supports,
- determination of critical load multiplier,
- etc.

Laboratory exercises using the CALFEM library should be checked or carried out in parallel in a calculation programme of your choice. It is recommended to carry out the exercises in groups.

Teaching methods

Lecture with multimedia presentation.
Laboratory - task solving.

Bibliography

Basic
1. Wei-Chau Xie, Differential equations for engineers, Cambridge University Press 2010
2. M. Asghar Bhatti, Fundamental Finite Element Analysis and Applications with Mathematica and MATLAB Computations, John Wiley& Sons, Inc., Hoboken,NewJersey, 2005
3. A.J.M. Ferreira, MATLAB Codes for Finite Element Analysis Solids and Structures Solid Mechanics and Its Applications, Springer, 2008
4. Y.W. Kwon & H. Bang, The Finite Element Method Using MATLAB, CRC Press, 2000
5. E. Onate, Structural Analysis with the Finite Element Method. Linear Statics. VOL.1 Basis and Solids, Springer, 2013
6. E. Onate, Structural Analysis with the Finite Element Method. Linear Statics. VOL.2 Beams, Plates and Shells, Springer, 2013
Additional
1. J.C. Butcher, Numerical Methods for Ordinary Differential Equations, John Wiley & Sons, Ltd., 2003
2. A.P.Boresi, K.P.Chong, S.Saigal, Approximate Solution Methods in Engineering Mechanics, John Wiley & Sons, Inc.,2003

Breakdown of average student's workload

	Hours	ECTS
Total workload	110	4,00
Classes requiring direct contact with the teacher	60	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	50	2,00