



COURSE DESCRIPTION CARD - SYLLABUS

Course name

AN APPLICATION OF THE BOUNDARY ELEMENT METHOD TO STATIC, DYNAMIC AND INITIAL STABILITY ANALYSIS OF ENGINEERING STRUCTURES [S5ILIT>ABEM]

Course

Proposed by Discipline

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Year/Semester

2/4

Level of study

Doctoral School

Course offered in

English

Form of study

full-time

Requirements

elective

Number of hours

Lecture

8

Laboratory classes

0

Other

0

Tutorials

0

Projects/seminars

0

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Knowledge: student knows the basics of linear algebra and matrix analysis of structures. Skills: student is able to write the above algorithm in the matrix form and apply it using commercial numerical tools. Social competencies: student is able to critically verify the obtained results.

Course objective

To acquaint students with the Boundary Element Method (BEM), which is a very useful numerical tool, competing with the well-known Finite Element Method (FEM).

Course-related learning outcomes

Knowledge

A PhD student who graduated from doctoral school knows and understands:

- 1) General application of numerical methods in mechanics, especially the Finite Element Method (FEM) and the Boundary Element Method (BEM), [P8S_WG/SzD_W01]
- 2) knows how to refer to the available literature in his own research, how to embed his own research in it. [P8S_WK/SzD_W07]

Skills

A PhD student who graduated from doctoral school can:

- 1) develop numerical procedures for classical problems of structural mechanics using the FEM and the BEM approaches, especially, [P8S_UW/SzD_U01]
- 2) consciously use scientific and commercial numerical computing packages (e.g.: Maple, Matlab, ABAQUS, etc.). [P8S_UW/SzD_U02]

Social competences

A PhD student who graduated from doctoral school is ready to:

- 1) develop numerical procedures for classical problems of structural mechanics using the FEM and the BEM approaches, especially [P8S_KK/SzD_U01]
- 2) critical evaluation of the results of own scientific research, [P8S_KK/SzD_K02]
- 3) formulating and solving scientific problems in the field of mechanics of materials and structures. [P8S_KK/SzD_K03]

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

A short test or an independent lecture.

Assessment criteria

40% - 50% sufficient, 50%- 65% average, 65%-80% good, 80%-95% very good, 95%-100% excellent.

Programme content

1. Introduction: Dirac's delta, Fundamental solution (or set of fundamental solutions), Singular Kernel Functions, Integral representation of the differential equation, Betti's Theorem, Types of Boundary Elements. Advantages and limitations of the method itself compared to other methods, e.g. the Finite Element Method (FEM).
2. Static analysis of shields and membrane structures, The Boundary Integral Equations, singular and non singular formulation of the Boundary Integral Equations. Initial configuration of the membrane. The statics of a membrane in the BEM approach is an introductory, preliminary element, very good for didactic purposes.
3. Static analysis of thin (Kirchhoff-Love) plate using classic and simplified formulation of the Boundary Integral Equations. Assembling of set of algebraic equation.
4. Dynamic analysis of thin (Kirchhoff-Love) plate using simplified formulation of the Boundary Integral Equations. Assembling of set of algebraic equation and the standard eigenvalue problem. Plate-water interaction (additionally).
In selected problems, BEM is much more effective than FEM.
5. Initial stability analysis of thin (Kirchhoff-Love) plate using simplified formulation of the Boundary Integral Equations. Assembling of set of algebraic equation and the standard eigenvalue problem.
Here, too, a number of tasks can be presented that can be solved quite quickly using BEM.

Course topics

1. Introduction: Dirac's delta, Fundamental solution (or set of fundamental solutions), Singular Kernel Functions, Integral representation of the differential equation, Betti's Theorem, Types of Boundary Elements. Advantages and limitations of the method itself compared to other methods, e.g. the Finite Element Method (FEM).
2. Static analysis of shields and membrane structures, The Boundary Integral Equations, singular and non singular formulation of the Boundary Integral Equations. Initial configuration of the membrane. The statics of a membrane in the BEM approach is an introductory, preliminary element, very good for didactic purposes.
3. Static analysis of thin (Kirchhoff-Love) plate using classic and simplified formulation of the Boundary Integral Equations. Assembling of set of algebraic equation.

Teaching methods

Lecture: classic bench, chalk and blackboard approach and multimedia presentation including illustrations and examples.

Bibliography

Basic

1. T. Burczyński, Metoda elementów brzegowych w mechanice, Wydawnictwo Naukowo-Techniczne, 1995 (The Boundary Element Method in mechanics, Scientific and Technical Publishing House, 1995).
2. J.T. Katsikadelis, Boundary Elements: Theory and Applications, Elsevier, 2002.
3. M. Guminiak, Metoda elementów brzegowych w analizie płyt, Wydawnictwo Politechniki Poznańskiej, 2016 (The Boundary Element Method in the analysis of plates, Poznań University of Technology Publishing House, 2016).
4. J. T. Katsikadelis, The Boundary Element Method for Plate Analysis, Elsevier, 2014.

Additional

1. K. Myślecki, Metoda elementów brzegowych w statyce dźwigarów powierzchniowych, Oficyna Wydawnicza Politechniki Wrocławskiej, 2004 (The Boundary Element Method in the static of surface girders, Wrocław University of Technology Publishing House, 2004).

Breakdown of average student's workload

	Hours	ECTS
Total workload	50	2,00
Classes requiring direct contact with the teacher	8	0,00
Doctoral student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation)	42	2,00