COURSE SYLLABUS AND COURSE REQUIREMENTS
ACADEMIC YEAR 2024/2025 SEMESTER 2

Course title	*STRUCTURAL OPTIMIZATION*
Course Code	***MSM407**ANEP*
Hours/Week: le/pr/lab	*0/0/3*
Credits	*3*
Degree Programme	*MSc Structural Engineering*
Study Mode	*full time*
Requirements	*semester grade with signature*
Teaching Period	*2nd semester*
Prerequisites	*Structure 1; Numerical methods for Civil Engineering*
Department(s)	*Civil Engineering*
Course Director	*Prof. Dr. Anikó Borbála Csébfalvi*
Teaching Staff	*Prof. Dr. Anikó Borbála Csébfalvi*

COURSE DESCRIPTION

Optimal design of engineering structures is a new design strategy that has only become widespread in recent decades, given the rapid development of computing. This design concept offers the possibility to realize economical lightweight structures. We can also take environmental considerations into account in the structural design and construction of our buildings and structures by minimizing our energy and material consumption.
The aim of this course is to learn a new concept of structural design. To show how we can build more efficient structures, for example by making structures as light as possible, yet able to withstand the loads placed on them. Over the last two decades, computational tools based on optimization theory have been developed that allow optimal structures to be found automatically. Complex mathematical programs are now available to carry out the modelling.

SYLLABUS

1. GOALS AND OBJECTIVES

The subject of structural optimization provides a way for structural engineers to extend and generalize their basic knowledge to a computer supported structural analysis and design. The purpose of the subject is to introduce a new concept in structural design, construct more efficient structures, e.g., by making structures as light as possible yet able to carry the loads subjected to them. In the last two decades computational tools based on optimization theory have been developed that make it possible to find optimal structures automatically.
Two textbooks are provided to help students to follow the teaching materials and understand the presented computational examples (see references). These textbooks content a basic knowledge to all three classes of geometry optimization problems of engineering structures: sizing, shape, and topology optimization. This course contains 14 units listed below of selected topics of structural optimization.
To complete the semester, you will need to study each selected unit and all the associated assigned material in AN INTRODUCTION TO STRUCTURAL OPTIMIZATION (by Peter W. Christensen and Anders Klarbring) and STRUCTURAL OPTIMIZATION, LECTURE NOTES (by Anikó Csébfalvi).
Please take time to read these; it is the best way to develop and test your knowledge.

Methodology of learning/teaching of the subject:
The application of the theory of structural optimization will be presented by simple structural problems where numerical solution methods are applied and demonstrated with help of Wolfram Mathematica (© 2015 Wolfram. All rights reserved). Legal licensed version available in room A 117. Student version: http://www.wolfram.com/solutions/education/students/.

2. COURSE CONTENT

	TOPICS
LABORATORY PRACTICE	1. Modelling of Structural Optimization Problems. 2. Structural Constraints. Structural modelling. 3. Minimal Weight Design Subject to Stress Constraints 4. Minimal Weight Design Subject to Stress and Displacement Constraints 5. Minimal Weight Design Subject to Buckling Constraints 6. Minimal Weight Design of Three-Bar Truss Subject to Stress Constraints 7. Minimal Weight Design of Three-Bar Truss Subject to Stress and Displacement Constraints 8. Optimization of Elastic-Plastic Structures. Limit States 9. Plastic Analysis of Continuous Beam 10. Plastic Analysis of Three-Bar Truss 11. Linear programming. Simplex Method 12. Linear Programming of 2D Problem 13. Theory of Primal-Dual Linear Problems. 14. The Dual Problem

DETAILED SYLLABUS AND COURSE SCHEDULE

PRACTICE, LABORATORY PRACTICE

week	**Topic**	**Compulsory reading; page number (from … to …)**	**Required tasks (assignments, tests, etc.)**	**Completion date, due date**
1.	Modelling of Structural Optimization Problems. Structural Constraints. Structural modelling. Minimal Weight Design Subject to Stress Constraints.	Structural Optimization page 8-21	Numerical solution using Wolfram Mathematica	4 February/2025
3.	Minimal Weight Design Subject to Stress and Displacement Constraints. Minimal Weight Design Subject to Stress and Buckling Constraints.	Structural Optimization page 21-29	Numerical solution using Wolfram Mathematica	18 February/2025
5.	Minimal Weight Design of Three-Bar Truss Subject to Stress Constraints. Minimal Weight Design of Three-Bar Truss Subject to Stress and Displacement Constraints	Structural Optimization page 29-41	Numerical solution using Wolfram Mathematica	4 March/2025
7.	**1st Midterm Exam**	Structural Optimization page 8-41	Numerical solution using Wolfram Mathematica	18 March/2025
9.	Plastic Analysis of Continuous Beam Plastic Analysis of Three-Bar Truss	Structural Optimization page 42-51	Numerical solution using Wolfram Mathematica	1 April/2025
11.	Linear programming. Simplex Method Theory of Primal-Dual Linear Problems. The Dual Problem	Structural Optimization page 51-67	Numerical solution using Wolfram Mathematica	15 April/2025
13.	**2nd Midterm Exam**	Structural Optimization page 42-67	Numerical solution using Wolfram Mathematica	29 April/2025

3. ASSESSMENT AND EVALUATION

ATTENDANCE

In accordance with the Code of Studies and Examinations of the University of Pécs, Article 45 (2) and Annex 9. (Article 3) a student may be refused a grade or qualification in the given full-time course if the number of class absences exceeds 30% of the contact hours stipulated in the course description.

Method for monitoring attendance *(e.g.: attendance sheet / online test/ register, etc.)*

Attendance sheet. Two times Midterm Exam during the semester. Activity monitoring using computer methods.

ASSESSMENT

Course resulting in mid-term grade *(PTE TVSz 40§(3))*

Mid-term assessments, performance evaluation and their ratio in the final grade

Type	Assessment	Ratio in the final grade
1st Midterm Exam	*max 90 points*	*45%*
2nd Midterm Exam	*max 90 points*	*45 %*
Activity during the whole semester	*max 20 points*	*10 %*

Opportunity and procedure for re-takes (PTE TVSz 47§(4))

The specific regulations for improving grades and resitting tests must be read and applied according to the general Code of Studies and Examinations. E.g.: all tests and assessment tasks can be repeated/improved at least once every semester, and the tests and home assignments can be repeated/improved at least once in the first two weeks of the examination period.

Students have the possibility to retake only one Midterm Exam during the semester. The Midterm Exams are compulsory.

Grade calculation as a percentage

based on the aggregate performance according to the following table

Course grade	Performance in %
excellent (5)	85 % …
good (4)	70 % ... 85 %
satisfactory (3)	55 % ... 70 %
pass (2)	40 % ... 55 %
fail (1)	below 40 %

The lower limit given at each grade belongs to that grade.

4. SPECIFIED LITERATURE

COMPULSORY READING AND AVAILABILITY

[1.] Csébfalvi, Anikó: Structural Optimization, Lecture Notes, ISBN: ISBN 978-963-429-330-9 (Print) University Press of University of Pécs, available: TEAMS

[2.] Christensen, Peter W. and Klarbring, Anders: An Introduction to Structural Optimization, Springer Science & Business Media, Oct 20, 2008 - Technology & Engineering, available: TEAMS