SUBJECT DATA SHEET AND REQUIREMENTS

last modified: 16th February 2016

AERO-ELASTICITY

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1	Code	Semester Nr. or fall/spring	Contact hours/week (lect.+semin.+lab.)	Requirements p / e / s	Credit	Language
	BMEGEÁTMW22	2.(3.*) fall	2+0+0	p	3	English

*: in case of enrolment in fall

2. Subject's responsible:

Name:	Title:	Affiliation (Department):
Dr. Tamás Kalmár-Nagy	associate professor	Dept. of Fluid Mechanics

3. Lecturer:

Name:	Title:	Affiliation (Department):
Dr. Gergely Szabó	bridge designer	Pont-TERV Ltd.
Dr. Tamás Kalmár-Nagy	associate professor	Dept. of Fluid Mechanics

4. Thematic background of the subject:
Dynamics, aerodynamics, numerical and experimental modelling

5. Compulsory / suggested prerequisites:
Compulsory: -
Suggested: -

6. Main aims and objectives, learning outcomes of the subject:
"The scientist does not study nature because it is useful; he studies it because he delights in it, and he delights in it because it is beautiful. If nature were not beautiful, it would not be worth knowing, and if nature were not worth knowing, life would not be worth living" Henri Poincaré.
Aero-elasticity is a multidisciplinary subject dealing with the interaction of flows and structural vibrations. The goal of this course is to give a broad perspective of aero-elastic phenomena in natural sciences and engineering. After learning the physical and mathematical background and understanding the worked examples the student will be able to solve simpler, but practical coupled problems. The trendy FSI (fluid-structure interaction) simulation will be introduced. Beyond the theoretical background for FSI, modelling problems will also be introduced for better understanding of the advanced numerical techniques.

7. Method of education: lecture: 2 hours/week

8. Detailed thematic description of the subject:
1. Introduction, requirements. Aero-elastic characterization of mechanical and civil structures, including tall buildings, bridges and infrastructures, wind turbines. Dynamical issues of structures, description and demonstration. Hierarchy of aerodynamic problems. Standards (Eurocode). Homework discussion.
2. Overview of mechanical modelling of structures. Finite Element Method and modal analysis within aero-elastic problems. Examples.
3. Modelling of structural dynamics. Timestepping method. Damping, mechanical nonlinearities.

4. Solving problems connected with aerodynamic phenomena. Wind buffeting, vortex-induced vibrations. Cable aerodynamics.
5. Linearized model to study flutter and other aerodynamic instabilities. Flutter coefficients. Feedback on homework assignments.
6. Nonlinear systems. Response and bifurcations.
7. Hopf bifurcation. Theory and practical applications.
8. Control, aerodynamic stabilization I; super and subcritical bifurcations.
9. Vibrations analogous with those of aero-elastic nature, e.g. machine tool vibrations.
10. Control of structural dynamics, alternatives to amplitude quenching. Mass, stiffness modification, mistuning. Overview of structural dampers (hydraulic dampers, Tuned Mass Dampers, other systems).
Inclusion of damping in the dynamic equations.
11. Aerodynamic stabilization II; optimizing flow forces by shape modification. Demonstration through section wind tunnel experimental and CFD simulation results. Project discussion.
12. Intro to coupled Fluid-Structure Interaction (FSI) simulations. Overview of coupling techniques (monolithic, staggered, implicit, explicit). Problems in dynamic CFD meshing. Full aerodynamic FSI simulations. Modelling questions, applications..
13. Demonstration of wind tunnel experiments. Model laws for aero-elastic problems. Analysis of flutter on section and aero-elastic wind tunnel models.
14. Submission of projects, presentations.

9. Requirements and grading

a) During the term: project (80%), assignments (10%) , test (10%).
Grading:
0%-39%: fail(1); 40%-54% pass(2), 55%-69%: satisfactory (3), 70%-84%: good(4), 85%-100%: excellent (5)

b) In the exam period: -

c) The students are subject to disciplinary measures against the application of unauthorized means at mid-terms, term-end exams and homework and the application of the 1/2013. (I.30.) Dean’s Order must be followed.

10. Retake and repeat: According to the Code of Studies and Exams of BME.

11. Consulting opportunities: Consultation hours: by email appointments and as it is indicated on the department’s website.

12. Reference literature (compulsory, recommended):

Dewey H. Hodges, G. Alvin Pierce: Introduction to Structural Dynamics and Aeroelasticity
Györgyi József: Szerkezetek dinamikája
Ludwig Győző: Gépek dinamikája
Lajos Tamás: Az áramlástan alapjai
Bojtár Imre, Gáspár Zsolt: Végeselem módszer építőmérnököknek
Downloadable materials: www.ara.bme.hu/oktatas/tantargy/NEPTUN/BMEGEATMW22

13. Home study required to pass the subject (Totally h/semester must be equal to credits × 30h!):

Contact hours	28	h/semester
Home study for the courses	8	h/semester
Home study for the mid-semester checks	4	h/check
Preparation of mid-semester homework	34	h/homework
Home study of the allotted written notes	16	h/semester
Home study for the exam		h/semester
Totally:	90	h/semester

14. The data sheet and the requirements are prepared by:

Name:	Title:	Affiliation (Department):
Dr. Gergely Szabó	bridge designer	Pont-TERV Ltd.
Dr. Tamás Kalmár-Nagy	associate professor	Dept. of Fluid Mechanics