ABDULLAH GÜL UNIVERSITY
GRADUATE SCHOOL OF ARCHITECTURE
COURSE DESCRIPTION AND SYLLABUS

Course Title	Code	Semester	T+L Hours	Credit	ECTS
STRUCTURAL ANALYSIS OF ARCHITECTURAL MASONRY STRUCTURES	ARCH622	Fall	2 + 1	3	10

Prerequisite Courses	NONE

Type	Elective
Language	English
Coordinator	Valentina BEATINI
Instructor	Valentina BEATINI
Adjunt	None
Aim	The course aims to provide suitable mechanical models for the study of the static and dynamic behavior of architectural masonry buildings. The preliminary thrust- line method and successively a rigid-body dynamics method are addressed so to interpret the real behavior of the masonry material and provide useful information in the recovery projects and structural restoration. The methodology, software and skills learned are here applied to a specific case selected with each student, while they are intended to a broader research intention.
Learning Outcomes	LO1. Understand the constitutive behavior of masonry material and its relationship with the modes of analysis L02 Be aware of the traditional design and assessment procedures behind historical masonry structures. L03 Learn and apply a rigid-body dynamics method for the assessment of the equilibrium of unreinforced architectural masonry structures of any formal complexity. L04 Interpret the results from the analyses in order to provide useful information for recovery and restoration projects. L05 Experiment the assessment of architectural masonry structures with a research oriented methodology.
Course Content	After an introduction into the constitutive characteristics of the masonry composite material and consequent challenges of its structural analyses, the course focuses on the equilibrium of arches, vaults and their assemblies. Through case studies of historical buildings area analyzed by comparing knowledge of the time they were constructed and results from rigid-body dynamics analyses. Meanwhile, within the course, students learn relevant up to date software, which they use to address the effective structural behavior of a reference case study.

WEEKLY TOPICS AND PRELIMINARY STUDY

Week	Topic	Assigned study-work
1	The masonry material	Selected readings from literature
2	Static of arches, from rules of proportion to the thrust line. in-class physical models.	Selected readings from literature
3	Static of arches, continued, the role of bending moment and shear. in class exercises.	Installation of Grasshopper and Rhino software, accordingly to instructions provided by the instructor
4	Intro to the parametric design environment, hands on. Selected software: Grasshopper (freeware) for Rhino (license available).	Exercise 1: manually design the max thrust line of an arch
5	Lecture free week. In class research on case studies	PPT of the study.
6	Parametric design of the thrust line, hands on	Exercise 1: manually design the max thrust line of an arch
7	Masonry vaults, overall flow of forces	Exercise 2: digital design of the max thrust line of an arch
8	Masonry vaults, flow of forces and the bond pattern	Selected readings from literature
9	Discussion of selected case studies	Project part a: submission of selected case study for approval.
	Mid-term exam	Project part b: digital parametric model of

		the case study Poster and digital file containing: - Project parts ab
10	Intro to rigid body dynamics	Selected readings from literature
11	Rigid body analyses, hands on. Selected software, freeware: ProjectChrono and VisualStudio	Exercise 3: run readymade examples
12	The parametric design – rigid body dynamics software interface, hands on	Project part e: Literature research on the case study
13	Composition and decomposition of forces, visualization	
14	Project part c: digital rigid-body dynamic model of the case study	Project part f: video of the digital rigid-body analyses of the failure mode of the case study, and interpretations
	FINAL EXAM Presentation of case studies	PPT presentation and digital file of the project, parts a to f

SOURCES	
Lecture Notes	Lecture notes and slides
Other Sources	**Course learning sources:** Parametric design, Grasshopper@ software tutorials: http://www.grasshopper3d.com/page/tutorials-1. Rigid-body mechanics, ProjectChrono software documentation: http://api.chrono.projectchrono.org/ **Additional Materials:** Literature sources for specific lessons provided during the course **Optional readings:** Jacques Heyman, 1997. The Stone Skeleton. Cambridge University Press.

COURSE MATERIALS SHARING	
Documents	Lecture notes and slides
Homework	Students will be given 3 analytical or simulation homeworks
Exams	1 Midterm and 1 Final Exam. The exams are progress reports of a case-study project, selected with each student.

EVALUATION SYSTEM		
SEMESTER STUDY	**NUMBER**	**CONTRIBUTION**
MIDTERM	1	40
Homework	3	15
FINAL EXAM	1	45
TOTAL		100

Course Category	
Architecture	40%
Engineering, civil	55%
Engineering, mechanical	5 %

RELATIONSHIPS BETWEEN LEARNING OUTCOMES AND PROGRAM QUALIFICATIONS							
No	Program Qualifications	Contribution Level					
		1	2	3	4	5	
1	To develop, improve and extend the knowledge and abilities in the related fields of architecture.				x		
3	To comprehend the relationship between architectural theory and other disciplines and to apply professional knowledge and criteria (gained) in interdisciplinary studies.			x			
5	To reach information by searching current literature and examine it seriously.				x		

7	To analyze, interpret and criticize individually a research topic within related fields of architecture.					x
12	To communicate verbally and written at least in one foreign language to be able to master and argue the literature view as well as concepts in professional area.			x		
13	To investigate various analyze methods, which could be supportive to the research, to use technology in the phase of processing effectively the outputs.					x

*Increasing from 1 to 5.

ECTS / WORK LOAD TABLE			
Activities	Number	Duration (Hours)	Total Work Load
Course Length (includes exam weeks: 16x total course hours)	15	3	45
Out-of-class Study Time (Pre-study, practice)	15	10	150
Internet search, library work, literature search	15	3	45
Homework	3	5	15
Midterm	1	20	20
Final Exam	1	25	25
Total Work Load			300
Total Work Load / 30			300/30
Course ECTS Credit			10