City University of Hong Kong
Course Syllabus

offered by Department of Architecture and Civil Engineering
with effect from Semester A 2021/22

Part I Course Overview

Course Title:	Structural Systems and Materials
Course Code:	CA29506
Course Duration:	1 Semester (Some courses offered in Summer Term may start a few weeks earlier than the normal University schedule. Please check the teaching schedules with CLs before registering for the courses.)
Credit Units:	3
Level:	A2
Proposed Area: *(for GE courses only)*	[] Arts and Humanities [] Study of Societies, Social and Business Organisations [] Science and Technology
Medium of Instruction:	English
Medium of Assessment:	English
Prerequisites: *(Course Code and Title)*	Nil
Precursors: *(Course Code and Title)*	Nil
Equivalent Courses: *(Course Code and Title)*	Nil
Exclusive Courses: *(Course Code and Title)*	Nil

Part II Course Details

1. Abstract

(A 150-word description about the course)

This course aims to strengthen students' conceptual understanding of the background mechanics behind diverse structural systems as how they transfer the external loads (in terms of axial forces, shears, moments and torsions) to the foundation through interconnected structural components. Students will see the relationships between the materials, structural elements, and architectural forms by studying the properties of construction materials (including concrete, masonry, steel, timber, and polymers), assembly of structural components (e.g., design and fabrication of connections/joints and boundary elements), and the force-resisting mechanism of various types of structural systems featuring distinct visual/aesthetic perceptions (such as the frames, trusses, arches, plates/shells, cables, and membranes). They will also investigate the behaviors and failure modes of the structural elements/systems through case studies, design exercises, and load testing of physical models. This course nourishes the students' abilities to develop innovative, healthy and effective architectures that are shaped naturally and explicitly by succinct structural patterns.

2. Course Intended Learning Outcomes (CILOs)

(CILOs state what the student is expected to be able to do at the end of the course according to a given standard of performance.)

No.	CILOs [#]	Weighting* (if applicable)	Discovery-enriched curriculum related learning outcomes (please tick where appropriate)		
			A1	*A2*	*A3*
1.	Describe the mechanical behaviors of various types of structural components and the load transmission paths in diverse structural systems		✓		
2.	Determine suitable materials for structural components based on the mechanical behaviors of the components in the systems			✓	
3.	Outline the design principles and limitations of various types of structural systems (including the frames, trusses, arches, plates/shells, cables, and membranes)		✓		
4.	Evaluate the health, effectiveness, and potential failure modes of the structural systems in architectural design proposals			✓	
5.	Develop innovative structural systems to concretize creative design ideas of architecture				✓
6.	Design the connections/joints and boundary elements, and depict the fabrication process for innovative structures				✓
** If weighting is assigned to CILOs, they should add up to 100%.*		100%			

[#] *Please specify the alignment of CILOs to the Gateway Education Programme Intended Learning outcomes (PILOs) in Section A of Annex.*

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to self-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

3. Teaching and Learning Activities (TLAs)

(TLAs designed to facilitate students' achievement of the CILOs.)

TLA	Brief Description	CILO No.						Hours / week (if applicable)
		1	2	3	4	5	6	
Lecture	Consists of oral presentations by instructors intended to present information on a particular subject. Other forms of teaching and learning activities will also be used to stimulate your participation during a lecture.	✓	✓	✓	✓		✓	
Tutorial	Activity complementary to the lecture classes to provide more opportunities for student-instructor and student-student interaction. Students will be engaged in more detailed discussions on the lecture materials and/or assessment tasks in a tutorial.	✓	✓		✓		✓	
Load-testing and Design Competition	Bridge design competition consisting of a load-testing activity on the students' models, exposing the weaknesses in the long-span structure and evaluating the material effectiveness of the design	✓		✓	✓	✓	✓	

Semester Hours:	3 hours per week
Lecture/Tutorial/Laboratory Mix:	Lecture (2); Tutorial (1); Laboratory (0)

4. Assessment Tasks/Activities

(ATs are designed to assess how well the students achieve the CILOs.)

Assessment Tasks / Activities	CILO No.						Weighting*	Remarks
	1	2	3	4	5	6		
Continuous Assessment: 100%								
Assignments	✓	✓	✓	✓	✓	✓	60%	
Load-testing and design competition	✓		✓	✓	✓	✓	20%	
Mid-term test	✓		✓	✓			20%	
Examination: 0%								
* The weightings should add up to 100%.							100%	

Students must attain a minimum mark of 30 in all assessment components AND an overall mark of 40 to pass the course.

5. Assessment Rubrics

(Grading of student achievements is based on student performance in assessment tasks/activities with the following rubrics.)

Assessment Task	Criterion	Excellent (A+, A, A-)	Good (B+, B, B-)	Fair (C+, C, C-)	Marginal (D)/ Pass (P) on P/F basis	Failure (F)
Assignments	1.1 Thorough understanding of the mechanical behaviors of various types of structural components and the load transmission paths in diverse structural systems; 1.2 Comprehensive understanding and accurate application of suitable materials for structural components based on the mechanical behaviors of the components in the systems; 1.3 Ability to explain the design principles and limitations of various types of structural systems (including the frames, trusses, arches, plates/shells, cables, and membranes); 1.4 Thorough understanding of the health, effectiveness, and potential failure modes of the structural systems in architectural design proposals; 1.5 Skilful and creative solution in innovative structural systems to concretize creative design ideas of architecture; 1.6 Generate practical solutions for the connections/joints and boundary elements, and depict the fabrication process for innovative structures; 1.7 Understanding of the mechanical behaviour of building materials; 1.8 Capable of selecting proper materials for structural elements based on the roles the elements play in the target structural system; 1.9 Capable of identifying the possible failure modes of the unhealthy structural systems in architectural design proposals;	High	Significant	Moderate	Basic	Not even reaching marginal level

	1.10 Capable of devising healthy structural systems for innovative architecture.					
Load-testing and design competition	2.1 Ability to explain the design principles and limitations of the long-span structure; 2.2 Thorough understanding of the health, effectiveness, and potential failure modes of the long-span structure; 2.3 Skilful and creative solution in innovative structural systems to concretize creative design ideas; 2.4 Generate practical solutions for the connections/joints and boundary elements, and depict the fabrication process for innovative structures.	High	Significant	Moderate	Basic	Not even reaching marginal level
Mid-term test	3.1 Thorough understanding of the mechanical behaviors of various types of structural components and the load transmission paths in diverse structural systems; 3.2 Ability to explain the design principles and limitations of various types of structural systems (including the frames, trusses, arches, plates/shells, cables, and membranes); 3.3 Thorough understanding of the health, effectiveness, and potential failure modes of the structural systems in architectural design proposals	High	Significant	Moderate	Basic	Not even reaching marginal level

Part III Other Information (more details can be provided separately in the teaching plan)

1. Keyword Syllabus
(An indication of the key topics of the course.)

Material properties, behaviors, and failure: concrete, masonry, steel, timber, and polymers; Behaviors and failure modes of structural components: beam and column, arch, plate and shell, compression and tension elements (truss, cable, membrane); Load path; Lateral load system; Material selection; Vector and section active systems; Form and surface active systems; Skin and bones; Architectural form, structural system, and visual/spatial perception; Introduction to form-finding and structural optimization; Structural failures; Limitations of structural systems; Structural detailing and fabrication; Optimization of structural elements and connections/joints; Local reinforcement and boundary elements.

2. Reading List

2.1 Compulsory Readings
(Compulsory readings can include books, book chapters, or journal/magazine articles. There are also collections of e-books, e-journals available from the CityU Library.)

1.	Nil

2.2 Additional Readings
(Additional references for students to learn to expand their knowledge about the subject.)

1.	Architectural Institute of Japan (2011). 世界建築的八種工學解剖 [譯本]. 田園城市, 臺北市, 台灣.
2.	Gaventa, S. (2001). Concrete Design. London: Mitchell Beazley
3.	Engel, Heino (2013). Sistemas Estruturais. Espanhol, Portugues. ISBN: 9788425218002
4.	Iwamoto, L. (2009). Digital Fabrications: Architectural and Material Techniques. New York: Princeton Architectural Press.
5.	Schierle, G.G. (2008). Structure and Design, Cognella. ISBN: 978-1-93426-937-4
6.	Spence, W. P. , Kultermann, E. (2011). Construction Materials, Methods and Techniques. Building for a sustainable future. New York: Delmar, Cengage Learning
7.	Smith, B.S. , Coull, A. (1991). Tall Building Structures - Analysis and Design. New York: John Wiley & Sons.
8.	Staib, G., Doerrhoefer, S., Rosenthal, M. (2008). Components and Systems: Modular Construction: Design, Structure, New Technologies. Basel: Birkhaeuser
9.	Stavridis, L. (2010). Structural Systems: Behaviour and Design, ICE Publishing. ISBN: 978-0727741066
10.	齋藤公男(2013). 建築新觀點 [譯本]. 如何出版社, 臺北市, 台灣.