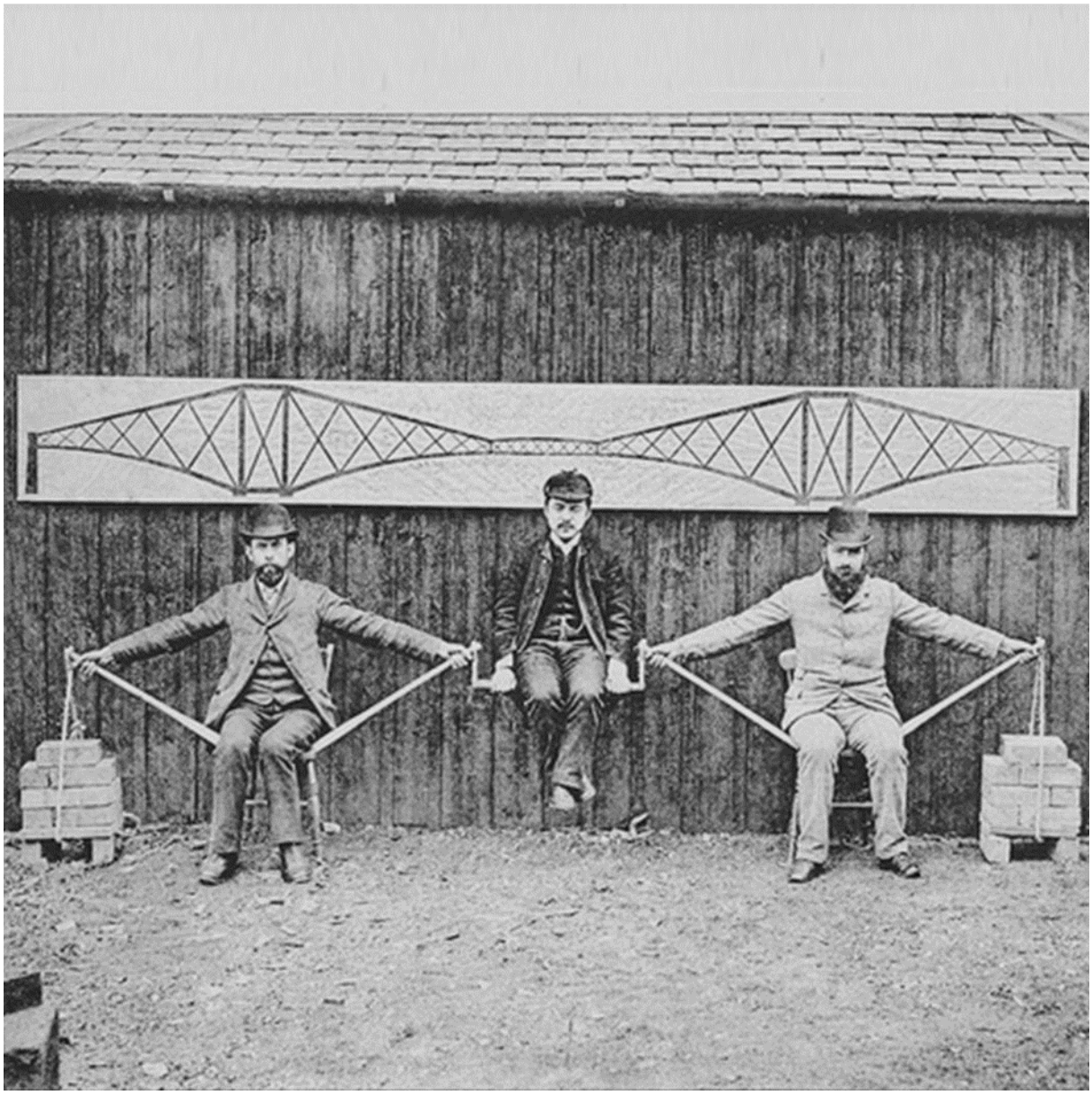

Sir John Fowler, Sir Benjamin Baker: Forth Bridge, South Queensferry, 1890

BUILDING TECHNOLOGY II: MATERIALS AND CONSTRUCTION

INSTRUCTORS
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ASSISTANT
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ISSUE

This course focuses on the fundamental knowledge and design methods of architectural structures. By revealing and analysing the internal forces within architectural structures through graphic statics, the course introduces the basic principles, systems, and materials of architectural structures in both qualitative and quantitative ways. The aim is to connect structural forms and forces through graphical methods, making structural design an essential element that enhances spatial form, rather than an obstacle to design.

DESCRIPTION

This course will introduce you to the hidden world of internal force flow within structural systems. With the tool of Graphic Statics, you will grasp the interdependency of forms and forces, and analyse them in diverse structural typologies from funicular ones like cables and arches to everyday ones like beams, columns, and frames.

On the one hand, you will appreciate the efficiency of structural typologies with a clear understanding of their internal equilibrium and dynamics. On the other hand, you will transcend these prototypes, transforming and combining them with spatial intentions, and pushing the boundaries of their architectural performance.

Subsequently, equipped with the knowledge of dimensioning, modelling, and materials, you will incorporate your understanding of forms and forces into a real architectural design in ARCH2112 Introduction to Architectural Design II.

In this course, you will learn to analyse and design structures not only as an efficient supporting system but as a powerful instrument for defining architectural space.

IMPACT AND SUSTAINABILITY

In this course, you will gain a new perspective on structural design by understanding internal force flow. Move structural design beyond monotonous, passive and procedural formulas and calculations to a graphical tool that actively strengthens the design. Through the lectures, exercises in class and practice in the design studio, you will learn and explore the following areas:

- The internal forces and their equilibrium within structural elements
- The relationship between the form of a structure and the internal forces within it
- Essential structural typologies
- Diagrams and operations of the physical and psychological equilibrium of structures
- The operation of structural design process
- Basic dimensioning of structural elements
- The integrated design approach to structure and architecture

This course begins with the basic principles of internal force equilibrium to provide a clear and direct understanding of the flow of forces. This approach allows for the minimization of redundant materials in structural design, maximizing the efficiency of structural forms. Through techniques like form-finding and structural analysis, students will learn to contribute to the sustainable use and reuse of structural materials in the future. Additionally, students can design innovative structural systems that enhance structural and spatial efficiency, thereby reducing material consumption in their designs and improving adaptability for use and maintenance.

METHODS

The course consists of two stages: lectures & exercises on structural design based on Graphic Statistics and large-scale conceptual design.

In the first stage, the course introduces students to structural design and static equilibrium. In weeks 3, 4, 5, 6, 7, 8, 10, 11, each lecture highlights the graphic static analyses of an essential structural typology, followed by corresponding exercises to be finished by individual students and critiqued in class. The remaining lectures supplement students with knowledge of dimensioning, modelling, and materials, bridging the gap between conceptual design and real practice.

In the second stage, students will select a specific structural type as the design prototype for applying structural equilibrium principles in their design studio. Working in groups, they will analyse similar structural systems both qualitatively and quantitatively, examining the principles of equilibrium, spatial performance, and the differences between these systems. This approach integrates learned structural knowledge with real design challenges, deepening their understanding of structures while enhancing structural thinking in design.

GUEST LECTURES

TBC.

DELIVERABLES

Stage 1 (Individual work):
Graphic statistical analyses of structural typologies
- in-class exercises in weeks 3, 4, 5, 6, 7, 8, 10, 11.

Stage 2 (Group work):
Structural design in ARCH 2112 Introduction to Architectural Design II
- Architectural and structural models (1:20)
- final structural design and analysis drawings
- final booklet

LEARNING OUTCOMES

At the end of the courses, students will be able to:

- visualize the internal forces within structural elements.
- understand the relationship between the form of a structure and the internal forces within it.
- modify the design of a structure in order to improve it.
- identify the most important structural typologies
- use graphic statics for the form-finding and analysis of structures.
- carry out basic dimensioning of structural elements.
- integrate structural thinking in their architectural design project.

ASSESSMENT SCHEME

01_In-class Exercises 40%
02_Final Review 30%
03_Project Book 30%

Total: 100%

COURSE FORMAT

1_Teaching Days
1. Students must attend for F2F teaching during these teaching hours.
   Teaching Day: Tue. 02:30 pm-05:15 pm
2. Teaching Venue: WMY_306
3. Field trips, lectures, and other learning activities may be scheduled outside of teaching days.

2_Student Study Effort (Total: 140 hrs)
1. Class Contact: 44 hrs (Lecture 33hrs, Tutorial 5.5hrs, Critique 5.5hrs, Field Trip)
2. Other Student Study Effort: 100 hrs (Studio / Self Study)

REQUIRED READINGS

Edward Allen, Waclaw Zalewski. *Form and Forces: Designing Efficient, Expressive Structures*. Hoboken: John Wiley & Sons, 2010.

Aurelio Muttoni. *The Art of Structures: Introduction to the Functioning of Structures in Architecture*, EPFL Press, 2011.

Bjørn N. Sandaker, Arne P. Eggen, Mark R. Cruvellier. *The Structural Basis of Architecture*, Routledge, 2011.

Maria Vrontissi, Juan J. Castellón González, Pierluigi D'Acunto, Lluís E. Monzó, and Joseph Schwartz. "Constructing Structural Concepts by Means of Physical Models," *International Association for Shell and Spatial Structures (IASS)*, Madrid, 2018.

Online source: *https://block.arch.ethz.ch/eq/drawing*

OTHER REFERENCES

Cruvellier, Mark R., Luben. Dimcheff, and Bjorn N. Sandaker. *Model Perspectives: Structure, Architecture and Culture*, London: Taylor and Francis, 2017.

Eduard Franz Sekler. "Structure, Construction, Tectonics," In G. Kepes (Ed.), *Structure in Art and Science*, Braziller, New York, 1965, pp. 89-95.

Shuaizhong Wang, Toni Kotnik, Joseph Schwartz, and Ting Cao. "Equilibrium as the common ground: Introducing embodied perception into structural design with graphic statics," *Frontiers of Architectural Research*, 11 (3), 2022: 574-589.

IMPORTANT NOTE TO STUDENTS

Expectations for Professional Conduct
The motto of The Chinese University of Hong Kong (CUHK) is "Through learning and temperance to virtue". This motto places equal emphasis on the intellectual and moral education of students. In addition to pursuing academic excellence, students of CUHK are expected to maintain and uphold the highest standard of integrity and honesty in their academic and personal lives, respect the rights of others and abide by the law. More information on Postgraduate studies can be found in the PG Student Handbook. https://www.gs.cuhk.edu.hk/

Attendance
Class attendance is required in all courses. For an excused absence, the instructor must be notified and presented with documentation of illness or personal matter. Please note: **Three (3)** or more unexcused absences may result in a failing grade for the course.

Academic Honesty
The Chinese University of Hong Kong places very high importance on honesty in academic work submitted by students and adopts a policy of zero tolerance on academic dishonesty

Attention is drawn to University policy and regulations on honesty in academic work, and to the disciplinary guidelines and procedures applicable to breaches of such policy and regulations. Details may be found at: http://www.cuhk.edu.hk/policy/academichonesty/.

With each assignment, students may be required to submit a statement that they are aware of these policies, regulations, guidelines and procedures.

Third-Party Assistance
All intellectual work essential to the design project must be completed by the student and cannot, under any circumstance, be outsourced to a third party (including, but not limited to a company, consultant, alumni, and/or friend).

In the design studio context, students may utilize external resources, such as printing services for presentation materials, and/or laser cutting and 3D printing services for prototyping purposes. Use of such third-party services constitutes non-intellectual work done by others. It is only permitted with prior written consent from the studio tutor and acknowledgment of such work done by the third party.

Assistance from other students or friends for aspects of project production also constitutes non-intellectual work done by others; this is allowed only if declared and acknowledged in a written statement attached to any such work that has received assistance.

Under all circumstances, students must declare all work done by others by completing the school's designated form before assessment. This form must include a detailed explanation of the third party's identity (name and relationship to the student), when and how they were utilized, and the specific tasks they performed in the project. The completed form, signed by the student, must be endorsed by the tutor and presented during the final review. The school will collect and retain this form for record-keeping purposes.

Failure to follow this code of conduct may be considered a case of academic dishonesty, to be reviewed by a disciplinary board, and possible failure of the course.

Artificial Intelligence
Unless approved by the Programme or School Director, any use of AI tools such as ChatGPT or image generation tools (Midjourney) etc. is strictly prohibited and may result in disciplinary action in accordance with university policy on academic honesty. Students may refer to the CUHK 'Use of Artificial Intelligence tools in Teaching, Learning and Assessments' – A Guide for Students.

Student Work
Submission of studio documentation must be complete and correctly formatted. Missing or incomplete submission of the documentation folder will result in the grade for the course being withheld. This will prevent registration for the following term or delay graduation. In addition, a grade deduction of *one letter grade* will be made.

GRADE DESCRIPTOR

Grade	Descriptor	Criteria	Points
A	Excellent	Outstanding performance on all learning outcomes.	4
A-	Very Good	Generally outstanding performance on all (or almost all) learning outcomes.	3.7
B+	Good	Substantial performance on all learning outcomes, OR high performance on some learning outcomes which compensates for less satisfactory performance on others, resulting in overall substantial performance.	3.3
B			3
B-			2.7
C+	Fair	Satisfactory performance on the majority of learning outcomes, possibly with a few weaknesses.	2.3
C			2
C-			1.7
D+	Pass	Barely satisfactory performance on a number of learning outcomes.	1.3
D			1
F	Failure	Unsatisfactory performance on a number of learning outcomes, OR failure to meet specified assessment requirements.	0

SCHEDULE

Important Dates

Final Presentation 15 APR 2025 (TUE)
Project Book Submission 22 APR 2025 (TUE)

Term 2: 6 January 2025 (Monday) – 19 April 2025 (Saturday)

WEEK 01		
07.01	**LECTURE**	Introduction to Structural Design
WEEK 02		
14.01	**LECTURE**	Introduction Equilibrium and Graphic Statics
WEEK 03		
21.01	**LECTURE AND EXERCISE**	Cables
WEEK 04		
28.01	**LECTURE AND EXERCISE**	Arch
WEEK 05		
04.02	**LECTURE AND EXERCISE**	Arch-Cables
WEEK 06		
11.02	**LECTURE AND EXERCISE**	Truss
WEEK 07		
18.02	**LECTURE AND EXERCISE**	Beams
WEEK 08		
25.02	**LECTURE AND EXERCISE**	Frames, Introduction of the Final Project
WEEK 09		
04.03	**READING WEEK**	(Optional) Final Project Tutorial
WEEK 10		
11.03	**LECTURE AND EXERCISE**	Deep beams and Plates
WEEK 11		
18.03	**LECTURE AND EXERCISE**	Columns and Dimensioning
WEEK 12		
25.03	**LECTURE AND TUTORIAL**	From 2D to 3D, Final Project Tutorial
WEEK 13		
01.04	**LECTURE**	Structural Materials
WEEK 14		
08.04	**TUTORIAL**	Final Project Tutorial
WEEK 15		
15.04	**FINAL REVIEW**	Final Project Presentation

Academic Honesty Statement

*Please print out and pin-up next to your works on your allocated panels

Relating to the 2024-25 Studio Review pin-up (BSSc students)

Please tick one of the following:

☐ All the work and models presented at the Final Review were made by me personally

☐ All the work and models presented at the Final Review were made by me.
with the exception of the following:

Under all circumstances, students must declare all work done by others by completing this form before the review. Provide a detailed explanation of the third party's identity (name and relationship to the student), when and how they were utilized, and the specific tasks they performed in the project.

Student's Name: _____ Date: _____

Signature: _____

Tutor's Name: _____ Date: _____

Signature: _____

Written Feedback to Students

Term: _____ **Grade:** _____

Course: _____ Date: _____

Assignment: _____ Student Name: _____

Studio Tutor: _____ Student ID: _____

Feedback from Studio Tutor:

Achievements:

Challenges: