MATERIALS AND CONSTRUCTION

INSTRUCTOR
XU, Liang
liangxu@cuhk.edu.hk

ISSUE

Architects wield the power to shape the built environment, yet too often, technical mastery is overshadowed and seen simply as a final solution. This course aims to inspire students to embrace the art of construction as a driving force in design and understand that the essence of a building lies in the poetry of its assembly. By expressing materials tactically, choreographing joints and connections, and celebrating structural logic, we can create captivating spaces that enhance the human experience. By fusing technical expertise with creative vision, we can design architecture that not only functions well but also profoundly transforms our living environment through innovative and sustainable approaches.

DESCRIPTION

Architects play an essential role in the construction process. Their deep understanding of various construction materials and their properties, capabilities, and limitations and their knowledge and expertise in specifying, detailing, and integrating these materials with different construction methods and structural systems are essential in creating safe, functional, and aesthetically pleasing buildings.

This course aims to provide students with a solid foundational knowledge of building technologies in materials, construction methods and structural principles while developing their ability to critically observe, explore, and integrate this technical information into a design process.

Students will be introduced to the importance of tectonics and the ethics of using materials. Students will be encouraged to discover the supply, processing and performance of the given building materials, together with the evolution and potential of the construction and structural systems.

The first two Building Technology courses are closely related and build on each other. The first course focuses on understanding materials, construction methods, and structural systems from a qualitative perspective, while the second course examines the same issues using the method of graphic statics - a quantitative approach.

IMPACT AND SUSTAINABILITY

This course will empower students to become technically proficient, design-driven designers capable of addressing the multifaceted challenges of the built environment. By gaining a deep understanding of structural systems, materials, and construction techniques, students will be able to explore a wide variety of creative and efficient design options. This integrated approach will allow them to bring their design ideas to life while ensuring that the technical and functional aspects of the design work in harmony with the intended spatial qualities and experiential characteristics. As the industry evolves with new materials and construction methods, students' ability to analyse technical implications, explore innovative solutions, and integrate diverse considerations will be highly valued.

To introduce and discuss the concept of “sustainability” focusing on Responsible Consumption and Production (SDG 12). It involves analysing material properties, selecting sustainable construction materials, and incorporating principles of responsible resource consumption and production into designs. By studying the environmental impacts of building materials and construction methods, students will learn to develop architectural solutions that promote more circular economic models within the construction industry. This knowledge will enable them to design buildings and urban environments that minimise waste, maximize the use of renewable and recyclable resources, and contribute to the overall sustainability of the built environment.

COURSE SYLLABUS

TOPIC 1: STRUCTURAL PRINCIPLES AND PRIMARY TYPES OF STRUCTURAL SYSTEMS IN ARCHITECTURE

Understanding basic structural principles, fundamental structural systems (such as form active, vector active, and section active), and their physical performance characteristics is essential. This allows you to select the most appropriate system for a given architectural design and explore a wider range of design possibilities, creating more innovative, expressive, and efficient buildings.

TOPIC 2: TECHNICAL ISSUES ASSOCIATED WITH MATERIALS AND CONSTRUCTION

This refers to the practical, engineering-focused challenges that arise when selecting, specifying, and working with different building materials and construction methods. It encompasses considerations like structural integrity, load-bearing capacities, durability, and the technical processes involved in assembly and installation. Understanding these technical and tectonic issues is crucial for ensuring the structural safety, functional performance, and constructability of architectural designs.

TOPIC 3: ISSUE OF SUSTAINABILITY AND INNOVATIVE BUILDING TECHNIQUES

This refers to the need for architects to consider the environmental impact and energy efficiency of the materials and construction methods they specify. It involves understanding how innovative building techniques can contribute to more sustainable and energy-saving design solutions. Addressing these issues is crucial for creating buildings with reduced carbon footprint and operational energy demands.

TOPIC 4: BUILDING TECHNOLOGY AND THE CREATION OF SPACE

This speaks to how material selection, construction methods, and the design of the structural systems could work with spatial design to create a certain spatial experience and atmosphere. Addressing these issues is essential for translating the architect's intended experiential qualities of a space into the built environment. The dual technical and creative aspects of architecture include the need to rigorously address material and construction challenges while also masterfully designing meaningful, experiential spaces.

METHODS

This course follows a lecture-based format, covering the key topics and issues outlined in the course syllabus. The weekly lectures will provide students with the foundational knowledge related to the subject matter. In addition to the lectures, students will engage in hands-on design projects, which bring together the training of making skills and design skills. These design projects, both individual and group-based, will allow students to apply the knowledge gained from the lectures, consolidate their understanding, and develop their own insights and perspectives. To support students during the design development process, the course also includes regular tutorials and workshops that offer guidance and assistance. Furthermore, presentations and pop-up exhibitions will be organized to showcase the student projects, encouraging peer learning and the exchange of ideas.

DELIVERABLES

For the design tasks, students will be required to submit a process book along with the physical models. The process book should comprehensively document the entire design process, including relevant materials such as sketches, scaled drawings, and photos of study models. This documentation will help students reflect on and communicate the steps they took, the decisions they made, and the insights they gained throughout the design development. The course will provide a basic guideline for the format of the process book to ensure a consistent and organized presentation. A detailed list of deliverables will be provided to students when each task is assigned.

LEARNING OUTCOMES

ABILITY

1. Analyse the technical and tectonic implications of material choices and construction methods
2. Compare the possibilities and limitations of different material systems
3. Identify the primary structural systems in the built environment
4. Describe the behaviour of a structure, including how it supports and delivers loads, achieves adequate stiffness, maintains stability, and develops internal forces
5. Use appropriate representational media, such as models, drawings, diagrams, and photographs, to convey information and explain design decisions
6. Work cooperatively with others in a team setting

UNDERSTANDING / KNOWLEDGE

1. Develop a comprehensive knowledge of building materials, their properties, and construction techniques
2. Familiarise yourself with the characteristics and design considerations of form-active, vector-active, and section-active structural systems
3. Understand the principles of structural behaviour in withstanding gravity and lateral forces

ASSESSMENT SCHEME

SPECIFIC ASSESSMENT

00_Attendance and In-class Participation (10%)
01_Individual Study Report (25%)
02_Group Projects (55%)
03_Final Quiz (10%)

Total: 100%

COURSE FORMAT

1_Teaching Days

1. Students must attend for F2F teaching during these teaching hours.
   Teaching Day: Tuesday 2:30 pm – 5:15pm
2. Teaching Venue: ARC G01
3. Field trips, lectures, and other learning activities may be scheduled outside of teaching days.

2_Student Study Effort_3 credit course (Total: 140 hrs)

1. Class Contact: 39 hrs (Lecture, Tutorial, Critique, Field Trip)
2. Other Student Study Effort: 100 hrs (Studio / Self Study)

REQUIRED READINGS

Deplazes, Andrea and Eidgenössische Technische Hochschule Zürich, eds. *Constructing Architecture: Materials, Processes, Structures: A Handbook.* Fourth, Revised edition. Basel: Birkhäuser, 2018.
Sandaker, Bjørn N., Arne P. Eggen, and Mark R. Cruvellier. *The Structural Basis of Architecture*. 2nd edition. Routledge, 2011.
Schodek, Daniel L., and Martin Bechthold. *Structures.* 7th edition. Boston: Pearson, 2014.

OTHER REFERENCES

Ching, Francis D. K. *Building Construction Illustrated*. 5th edition. Hoboken, New Jersey: John Wiley & Sons, Inc, 2014.
Ching, Francis D. K., Barry Onouye, and Douglas Zuberbuhler. *Building Structures Illustrated*. Second Edition. Hoboken, New Jersey: John Wiley & Sons, 2009.
El Khouli, Sebastian, Viola John, and Martin Zeumer. *Sustainable Construction Techniques: From Structural Design to Material Selection: Assessing and Improving the Environmental Impact of Buildings*. DETAIL - Institut für internationale Architektur-Dokumentation GmbH & Co. KG, 2015. https://doi.org/10.11129/9783955532390.
Engel, Heino. *Tragsysteme = Structure systems*. 5th edition. Aufl. Ostfildern: Hatje Cantz, 2013.
Herzog, Thomas, Julius Natterer, Roland Schweitzer, Michael Volz, and Wolfgang Winter. *Timber Construction Manual*. Basel: Birkhäuser, 2012.
Muttoni, A. *The Art of Structures: Introduction to the Functioning of Structures in Architecture*. Abingdon, Oxford, UK ; New York, NY: EPFL Press/Routledge, 2011.
Pfeifer, Günter, and Rolf Ramcke. *Masonry Construction Manual*. Basel Boston Berlin: Birkhäuser, 2001.

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.

Term 1: 2 September 2024 (Monday) – 30 November 2024 (Saturday)

WEEK 01		
03.09	**SYSTEM & GEOMETRY**	Course Introduction and Lecture
WEEK 02		
10.09	**MASONRY**	Lecture and In-class Workshop
WEEK 03		
17.09	**TIMBER**	Lecture and Individual Task Step 1- Introduction
WEEK 04		
24.09	**CONCRETE**	Lecture and Individual Task Step 2 - Introduction
WEEK 05		
01.10	**HOLIDAY**	**NO CLASS**
WEEK 06		
08.10	**BUILDING STRUCTURES**	Lecture and Tutorial on Individual Task Step 2
WEEK 07		
15.10	**STATICS**	Lecture
WEEK 08		
22.10	**FORCE, LOAD AND STRESS**	Lecture and Group Project Part 1 - Introduction
WEEK 09		
29.10	**WORKSHOP**	Group Project Part 1 - Testing and Group Project Part 2 - Workshop
WEEK 10		
05.11	**SECTION-ACTIVE**	Lecture and Group Project Part 2 - Group Tutorial
WEEK 11		
12.11	**FORM-ACTIVE**	Lecture and Group Project Part 2 - Testing
WEEK 12		
19.11	**VECTOR-ACTIVE**	Lecture and Group Project – Sharing
WEEK 13		
26.11	**NO CLASS**	**FOR REVIEW WEEK**
WEEK 14		
03.12	**FINAL QUIZ**	

Grade	Descriptor	Criteria	Points
A	Excellent	Comprehensively excellent performance on all aspects of the design intention, development, technical resolution and presentation. Achieving all learning outcomes with distinction.	4
A-	Very Good	Generally outstanding performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes with merit.	3.7
B+	Good	Substantial performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes satisfactorily.	3.3
B			3
B-			2.7
C+	Fair	Fair performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes at a passing standard.	2.3
C			2
C-			1.7
D+	Pass	Barely satisfactory performance on the design intention, development, technical resolution and presentation. Achieving all learning outcomes at a barely satisfactory standard.	1.3
D			1
F	Failure	Unsatisfactory performance on the design intention, development, technical resolution and presentation. Not achieving all learning outcomes.	0

Written Feedback to Students

Term: _____ **Grade:** _____

Course: _____ Date: _____

Assignment: _____ Student Name: _____

Studio Tutor: _____ Student ID: _____

Feedback from Studio Tutor:

Achievements:

Challenges: