taz Neubau, Berlin, E2A, 2018. Photo by XU liang.

BUILDING TECHNOLOGY I: MATERIALS AND CONSTRUCTION

INSTRUCTOR
XU, Liang liangxu@cuhk.edu.hk

ISSUE

Technical knowledge of materials, construction, and structures is vital for any building endeavor. This foundation is rooted in traditional techniques and practical experience, while also adapting to the latest advancements in science and technology. This course aims to inspire students to discover the art of construction as a driving force in design and to recognize that the essence of a building lies in the poetry of its assembly. By expressing materials strategically, choreographing joints and connections, and celebrating structural logic, we can craft spaces that enrich the human experience. By integrating technical knowledge with creative vision, we can design architecture that not only functions effectively but also profoundly transforms our living environment through economic, innovative, and sustainable approaches.

DESCRIPTION

Architects play a pivotal role in the design-build process, where their in-depth understanding of construction materials is essential. Knowledge of the properties, capabilities, and limitations of various materials is crucial for creating buildings that are not only safe and functional but also aesthetically pleasing. This course aims to equip students with a solid foundational knowledge of building technologies, encompassing materials, construction methods, and structural principles.

Students will study the supply chain, processing, and performance characteristics of various building materials, alongside the evolution and potential of different construction and structural systems. By developing the ability to critically observe and integrate technical information into the design process, they will also gain insights into the significance of tectonics and the ethical considerations surrounding material use. Understanding these aspects is vital, as it empowers future architects to make informed decisions that enhance both design integrity and environmental responsibility.

This required course also connects with the second-year design studios—*Measure* and *Prototype*. Measurement is fundamental for quantitative evaluations in building technology, addressing dimensional limits, such as the largest sizes of panels that can be produced and transported, and structural performance metrics, including the maximum tensile strength of materials like steel cables. Throughout the course, students will engage in testing various measuring methods, investigating aspects such as the maximum height achievable with certain construction techniques, the waste generated by particular design schemes, and the weight of their structures in relation to load-bearing capacities.

Additionally, the course will present a variety of built projects, encouraging discussions on their differences and evolution concerning construction methods and structural concepts. This exposure provides students with the essential knowledge needed for material exploration and prototype development in the design studio in Term 2, fostering a deep understanding of experimentation in building construction.

Furthermore, the first two Building Technology courses are intricately connected and build upon one another. The initial course emphasizes understanding materials, construction

methods, and structural systems from a qualitative perspective, while the subsequent course explores these topics through the quantitative lens of graphic statics.

IMPACT AND SUSTAINABILITY

This course will empower students to become technically proficient 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 students 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

1. Individual Study Report (25%)
2. Group Projects (50%)
3. Quizzes (25%)

Total: 100%

Feedback to Students
For both individual study and group design tasks, the course instructor will conduct tutorials that involve discussions of sample student works and commonly observed challenges. Additionally, a Q&A session will be held to address specific inquiries. Written feedback will be provided to each student for their individual study and to each group for their design tasks.

COURSE FORMAT

Teaching Days
1. Students must attend for F2F teaching during these teaching hours.
   Teaching Day: Thursday, 9:30 am – 12:15 pm
2. Teaching Venue: WMY 406
3. Field trips, lectures, and other learning activities may be scheduled outside of teaching days.

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 undergraduate studies can be found in the UG Student Handbook. https://rgsntl.rgs.cuhk.edu.hk/aqs_prd_applx/Public/Handbook/

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
Students are advised against using AI tools for all course tasks. Closed-book quizzes are specifically designed to evaluate a student's comprehension of the course material. Using AI tools undermines the authenticity of the assessment and violates academic integrity. Furthermore, in both individual exercises and group design projects, students are required to produce original work that reflects the knowledge and skills acquired throughout the course.

Students may refer to Approach 1 of the CUHK 'Use of Artificial Intelligence tools in Teaching, Learning and Assessments' – A Guide for Students.

Student Work
Submission of course work 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.

External Examination
Of paramount importance to the academic rigour and professional relevance of the architecture programme, the external examination process serves as a critical and impartial review mechanism. An invited panel of distinguished practitioners, academics, and industry experts convenes to rigorously evaluate the school's pedagogical ecosystem. This comprehensive audit scrutinises the fairness and consistency of the internal assessment process, benchmarks the standard and ambition of student work against national and international norms, and provides invaluable feedback on the intellectual and pedagogical direction of the curriculum itself.

As a cornerstone of this process and a mandatory graduating requirement, final-year students from both the Bachelor of Social Sciences (Architecture) and Master of Architecture programmes must present their final project and portfolio work in person. This formal defence before the external panel not only validates the authenticity and depth of their learning but also simulates a professional practice environment, demanding they articulate their design rationale, critical thinking, and technical resolution to an authoritative audience, thereby preparing them for the collaborative and discursive nature of the architectural profession.

Term 1: 1 September 2025 (Monday) – 29 November 2025 (Saturday)

WEEK 01		
04.09	**SYSTEM & GEOMETRY**	Course Introduction Lecture and Individual Task 1 - Introduction
WEEK 02		
11.09	**TIMBER**	Lecture and Individual Task 1 - Tutorial
WEEK 03		
18.09	**MASONRY**	Lecture and Workshop
WEEK 04		
25.09	**CONCRETE**	Lecture and Individual Task 2 - Introduction
WEEK 05		
02.10	**BUILDING STRUCTURES**	Lecture and Individual Task 2 - Tutorial
WEEK 06		
09.10	**STATICS**	Lecture and Group Project Part 1 - Introduction
WEEK 07		
16.10	**FORCE, LOAD AND STRESS**	Lecture and Group Project Part 1 – Testing
WEEK 08		
23.10	**FORCE, LOAD AND STRESS (cont.)**	Lecture and Group Project Part 2 - Introduction & Workshop
WEEK 09		
30.10	**SECTION-ACTIVE**	Lecture and Group Project Part 2 - Group Tutorial
WEEK 10		
06.11	*No Class*	*Congregation (individual tutorial based on appointment)*
WEEK 11		
13.11	**FORM-ACTIVE**	Lecture and Group Project Part 2 – Testing
WEEK 12		
20.11	**VECTOR-ACTIVE**	Lecture Course Summary
WEEK 13		
27.11	*No Class*	*Review Week (individual tutorial based on appointment)*
WEEK 14		
(dates TBC)	**FINAL SUBMISSION & QUIZ**	

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

Written Feedback to Students

Term: _____ **Grade:** _____

Course Code: _____

Review: _____

Tutor: _____

Student Name: _____

Student ID: _____

Feedback from Course Instructor:

Achievements:
Challenges: