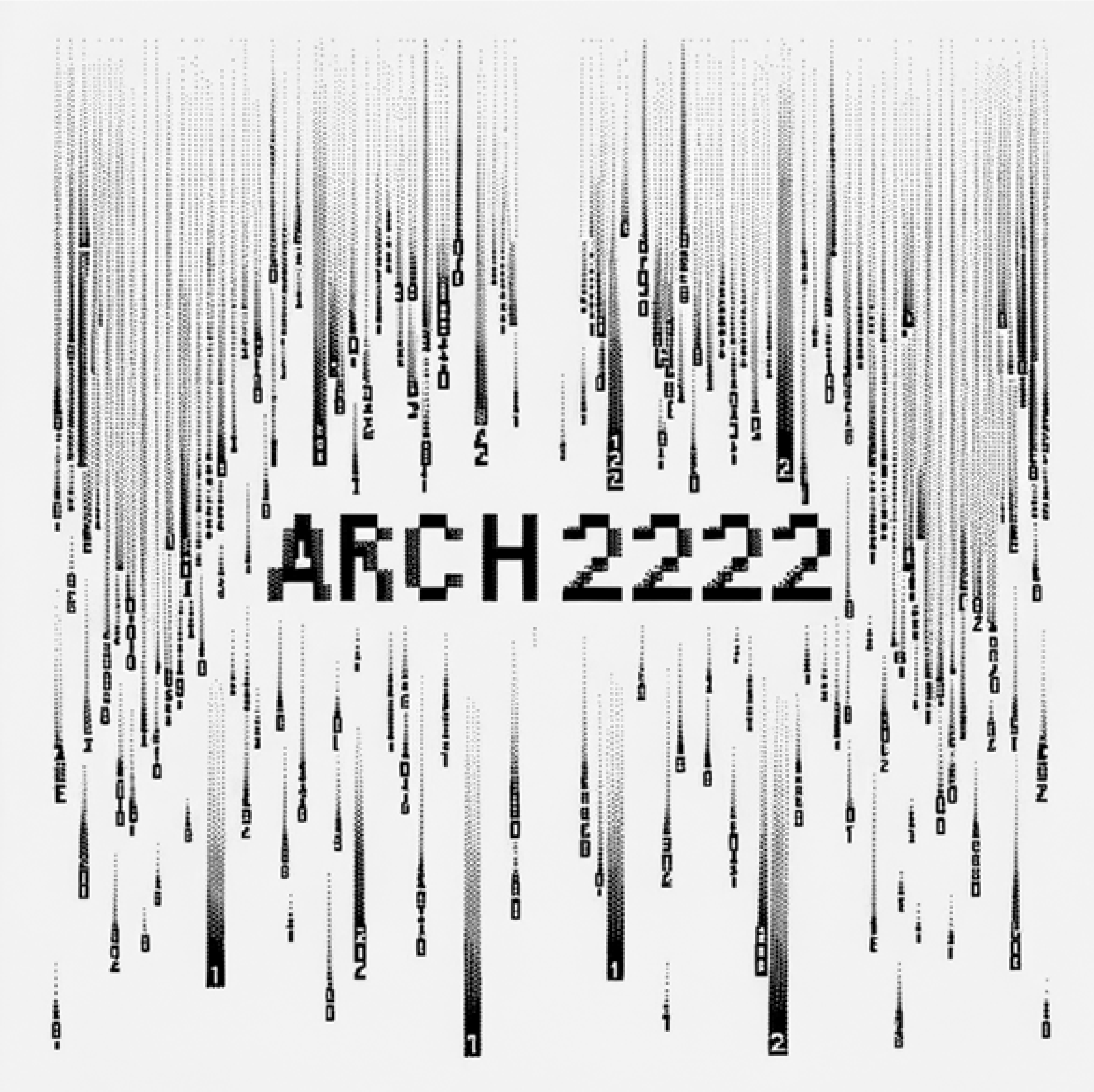

ARCH2222 text in Black & White ASCII Matrix Style." DALL-E, version 3, OpenAI, July 2025

DIGITAL MEDIA

INSTRUCTOR
FINGRUT, Adam adam.fingrut@cuhk.edu.hk

ISSUE

ARCH2222 equips students with computational design methods to enable innovative, data-driven, and materially informed architecture. Through the themes of digitization, design, automation, and synthesis, students will develop a deeper understanding of how computation informs architectural thinking and production. The course prepares future architects to navigate an evolving digital landscape.

DESCRIPTION

This core course introduces students to computational design methods as an iterative approach to problem-solving in architecture. Through exposure to automation tools, digital workflows, and hardware systems, students will engage with contemporary and emerging technologies, preparing them to navigate the evolving landscape of design.

In parallel to the course's lecture schedule, the course will collaborate with an undergraduate robotics course from Mechanical Automation Engineering (MAE) department. Students from both disciplines will form transdisciplinary teams to develop automated robotic solutions for architectural applications.

The course is structured into three key phases:

Phase 0: Digitization & Modeling Methods
Students will learn introductory 3D modeling methods, focusing on the relationships between points, lines, curves, surfaces, and volumes to construct efficient and effective digital geometry. They will explore MESH and NURBS modeling, understanding their differences in structure, precision, and application.

Phase 1: History, Theory, and Literacy
Students will gain a broad understanding of computing technology, tracing the development of computer-aided design (CAD) tools and their role in architectural practice. They will develop computational literacy, exploring diverse computer languages for analyzing and controlling design geometry.

Phase 2: Exploration, Application, and Translation
Building on theoretical foundations, students will engage in hands-on exploration, integrating computational design with digital tools for digitization, geometric manipulation, and synthesis. Using a Problem-Based Learning (PBL) approach, they will iteratively explore, develop, and test design geometries, preparing them to apply computational techniques to architecture.

Each lesson is framed around three distinct visual language abilities:
1. Human language – verbal and written articulation of design concepts
2. Design Abstraction – articulation of workflows and methods
3. Graphical coding – node-based visual programming for geometry outcomes

Students will examine how languages influence developable, repeatable architectural geometries, shaping contemporary workflows. Weekly activities will help to work through problems as 1) input; 2) design as data selection, modification, and manipulation; 3) synthesis from abstract to material.

Phase 3: Connecting Theory to Practice
The course bridges architectural design, theory, and practice with emerging technologies, including computational design, artificial intelligence, CNC fabrication, and robotics. Students will gain an

awareness of critical methods for synthesizing design works, exploring complex forces that shape architectural outcomes. By engaging with design thinking principles, they will connect abstraction to material translation, iterating through observation, analysis, ideation, prototyping, testing, and reflection.

IMPACT AND SUSTAINABILITY

This course equips future architecture with the computational literacy necessary to thrive in a rapidly evolving digital and AI-driven design landscape. As technology reshapes architectural processes, students must adapt to new tools and develop critical engagement with digital workflows, algorithms, and automation. Understanding foundational methods for translating design intentions into computational directives, students will gain the ability to control digital processes, positioning themselves as informed designers and drivers of innovation.

Students will engage with an iterative approach toward assignments, encouraging reflections on decision-making, optimisation, and trade-offs between digital aspirations and material realities. By integrating data-driven methodologies, evidence-based reasoning, and computational problem-solving, students will be empowered to navigate increasingly complex design challenges found in design studios and architecture practice.

METHODS

PHASE 0 – DIGITIZATION AND MODELING METHODS

Digital Environments and Drawing (Week 1)
Overview / Questions
1. What is a 3D digital design environment, and how does it relate to architecture?
2. How do points, lines, curves, surfaces, and volumes form the basis of geometric modeling?
3. What are the basic principles of precision and efficiency in digital drawing?
4. How do software interfaces influence design thinking and workflow?

Activity
1. Install and familiarize with 3D modeling software (interface navigation and tool overview).
2. Create basic geometric primitives (points, lines, curves, and surfaces).
3. Explore coordinate systems and spatial organization in digital space.
4. Discuss modeling best practices: responsible and efficient geometry creation.

Surface Modeling Methods (Week 2)
Overview / Questions
1. What are Mesh-based models, and how do they represent geometry?
2. How do NURBS (Non-Uniform Rational B-Spline) models differ in precision and smoothness?
3. What are the strengths and limitations of Mesh vs. NURBS modeling?

Activity
1. Create and manipulate Mesh objects, understanding polygon structures.
2. Explore NURBS modeling workflows for smooth surface creation.
3. Compare topological properties between Mesh and NURBS geometries.
4. Discuss strategies for optimizing geometry for fabrication and computational efficiency.
5. Investigate digitization methods, importing, and integrating into 3D environments.

Synthesis Methods – 3D to Reality (Week 3)
Overview / Questions
1. How do digital models transition from 3D space to 2D representation?

2. What are projection techniques for extracting plans, sections, and elevations?
3. How does vector-based geometry influence fabrication and construction?
4. What file formats and workflows optimize geometry for real-world applications?

Activity
1. Generate 2D drawings from 3D models (sections, elevations, unfolded surfaces).
2. Experiment with exporting vector-based data for fabrication workflows.
3. Explore file conversion methods for interoperability across design software.
4. Understand optimization principles for efficient translation from model to material.

PHASE 01 – HISTORY, THEORY, AND LITERACY

Computational Design (Week 4)

Overview / Questions
1. What is computational design?
2. What is the history of computing technology?
3. What are some important theoretical ideas associated with computing and design?
4. What is serialism? What do computers do well and badly?

Activity
1. Learn to draw points, curves, primitives (using variables)
2. Discuss "responsible and efficient modeling methods"
3. Explore computational design interfaces and basic methods.

Computer Languages (Week 5)

Overview / Questions
1. Understanding high level computing languages. What are they?
2. Where are they situated between human language, poetry, metaphor, and high-low voltage signals as 1s and 0s.
3. What is a syllogism?
4. Understanding high level computing languages – what are they?
5. What is a scripted language?
6. What is a graphical computer language?

Activity
1. Expand understanding of the relationship between GH and 3D environment
2. Integrating and Separating objects

Variables and Operators (Week 6)

Overview / Questions
1. What are variables and operators (English, math, geometry, etc.)
2. How do we instantiate and control variables?
3. How do we apply operators to variables to create change?
4. How can we perform analysis on geometry to learn about its attributes?
5. How can we impose, pick, select and then use areas of geometrical interest?

Activity
1. Developing Points, Vectors, Curves
2. Manipulating geometry with operators and transformations
3. Geometry Analysis Tools and Applications

Data and Lists (Week 7)

Overview / Questions
1. What is data?
2. What are data types?
3. How do we collect data?

4. How do we find our data later?
5. How can we extract / integrate data into design?

Activity
1. Understanding "garbage in garbage out" and how to cleanse data.
2. Simple List Management
3. Data typology and inheritance
4. Importing and exporting lists; linking to geometry and operators.

Patterns (Week 8)
Overview / Questions
1. What are patterns and how do we express them?
2. What is Boolean logic and how does it work?
3. How can we understand truth, falsehood, equivalence?
4. What are conjunctions and disjunctions?

Activity
1. Understanding and applying Boolean Variables (true/false).
2. Using Truth Tables
3. Using Boolean operations (conjunction, disjunction)
4. Understanding how to apply / dispatch Boolean states to geometry.

Loops and Conditional Statements (Week 9)
Overview / Questions
1. How can we generate complex lists?
2. What are conditional statements?
3. What are loops, how do they work, and what do they represent?
4. What is recursion?
5. How can loops and conditional statements benefit geometry?

Activity
1. Sequence and series
2. Existential and Universal Quantification
3. Applied patterns to geometry generation and analysis
4. Weaving and Dispatching Data
5. NURBS Surface analysis (U/V)
6. Surface division / subdivision / reconstruction

PHASE 02 – EXPLORATION, APPLICATION, AND TRANSLATION
Exploring Tools and Applications (Week 10)
Overview / Questions
1. What specific tools are being developed to streamline design processes?
2. What is emergent design?
3. What is a bottom-up vs. top-down approach to design in architecture?
4. How can tools help with design optimization?

Activities
1. Explore various applications and plugins for design exploration and optimization.
2. Explore tools for conducting analysis on site and building performance.

Synthesis (Week 11)
Overview / Questions
1. What is Synthesis?
2. What are the differences and realities that we often encounter when undergoing translation from digital to physical?

3. How can translation and synthesis direct, inform, refine, and inspire design geometry?
4. What is a computer numerically controlled device?

Activities

1. Explore how CNC machines work (printers, 3D printers, cutters).
2. Additive vs reductive fabrication and construction methods.
3. Understand edge conditions.
4. Understand the limits of translation from pure/primitive geometry and the realities of built environment.
5. Physical properties and realities of material, fabrication, assembly, and how they can inform design and construction setups.
6. Understanding computational tools can enhance, refine, and inform translation and synthesis.

Automation Technology / Robotics / AI Tools (Week 12)

Overview / Questions

1. What are robotics? How are they different to CNC machines?
2. What are multi-axis machines and how do they work?
3. What control systems exist to connect architects with robotic technologies?
4. How can I take advantage of AI for design and the built environment?

Activities

1. Explore uses for robotics in fabrication, assembly, and on-site construction.
2. Develop an end effector and robotic system based on specific workflows.
3. Understand different types of robots and their specific or general usage cases.
4. Explore methods for AI adoption and integration into design processes.
5. Gain awareness of ethical issues surrounding AI for design in architecture.

Final Presentations (Week 13)

FINAL PROJECT

For the midterm and final projects, students will form groups and collaborate with peers from the undergraduate robotics course in the Mechanical Automation Engineering (MAE) department. This transdisciplinary partnership is designed to illustrate the collaborative nature of future data-driven practice, the importance of learning through discovery of system challenges and opportunities, and iterative design converging toward positive outcomes.

Architecture students will:

1. Develop an artistic or architectural concept suitable for robotic execution.
2. Generate and refine 3D models and computational design workflows.
3. Supply structured data (geometry, parameters, logic) to MAE collaborators for robotic implementation.

MAE students will:

1. Design and build robotic control systems capable of executing the architectural tasks.
2. Translate architectural data into robotic movement and fabrication strategies.
3. Test and iterate robotic solutions based on design feedback and technical constraints.

Collaboration Dynamics:

1. Teams will coordinate regularly to align design goals with robotic capabilities.
2. Projects will evolve through iterative development, responding to equipment limitations, learning curves, time constraints, and material realities.
3. While assessments remain discipline-specific, students are expected to demonstrate effective

communication, adaptability, and problem-solving across domains.
4. This collaboration encourages students to engage in real-world complexities of interdisciplinary design, preparing them for future roles in technologically integrated architectural practice.

Through this collaborative project, students will:
1. Gain experience working in transdisciplinary teams across architecture and engineering.
2. Develop skills in translating abstract design concepts into executable robotic tasks.
3. Learn to communicate design intent through structured data and visual programming.
4. Understand the constraints and opportunities of robotic fabrication and control systems.
5. Apply iterative design thinking to navigate real-world limitations and refine outcomes.
6. Demonstrate critical reflection on the relationship between digital design and physical execution.

High-quality documentation is essential for assessment. Students must:
1. Maintain clear records of design development, including sketches, diagrams, and digital models.
2. Log communication and coordination efforts with MAE collaborators.
3. Document data workflows, including inputs, transformations, and outputs.
4. Reflect on challenges, decisions, and adaptations made throughout the project.
5. Submit well-organized presentation materials that narrate the design and execution process.

Documentation will be evaluated for clarity, completeness, and its ability to communicate both technical and conceptual aspects of the project. It is a key component of both midterm and final assessments.

LEARNING OUTCOMES

The goal of this course is to develop student confidence in the practical applications computation for the digital design environment. Students will become conversant in the rudiments of high-level computer language (syntax and semantics), gain confidence in defining an architectural problem, developing a response based on original procedural logic and presenting outcomes and knowledge gained through the process.

1. Ability to collaborate and participate in architectural research.
2. Ability to demonstrate verbal and written communication skills.
3. Ability to explore and develop graphic skills developed through novel technologies.
4. Ability to research drawing and geometry problems for architecture.
5. Ability to demonstrate critical thinking skills.
6. Ability to develop a problem-solving approach to challenges faced in architecture and design.
7. Awareness and literacy of computational languages in the context of architectural design and development of 3D modeling techniques.
8. Awareness of mathematical concepts such as sets, and series as applied to geometry and surface analysis.
9. Awareness of mathematical concepts such as disjunctive and conjunctive syllogisms, universal and existential quantification, and predicate calculus as an approach to practical architectural design.
10. Ability to develop and execute digitization, design, and synthesis methods
11. Awareness of the history and theory and future of digital technologies in the architecture and design field.

ASSESSMENT SCHEME

Weekly Quiz	10%
Assignments	20%
Final Project - A	30%
Final Project - B	40%

Total: 100%

Each assessment result will be released to students upon completion accompanied by written comments based on student progress and performance.

ASSESSMENT CRITERIA

Weekly Quiz (10%)

A	Demonstrates complete and precise understanding of course concepts and principles. Answers are logically sound, syntactically correct, and show insightful connections to design practice.
A-	Strong grasp of concepts with minor errors or omissions. Shows good reasoning and application but lacks full depth or clarity in one area.
B	Adequate understanding with some conceptual or syntactic errors. Answers are generally correct but lack precision or depth.
C	Basic understanding with multiple errors or unclear reasoning. Limited ability to connect theory to practice.
D	Minimal understanding. Answers are incomplete, mostly incorrect, or show poor engagement with course material.
F	No meaningful understanding demonstrated. Answers are missing, irrelevant, or entirely incorrect.

Assignments (20%)

A	Work is well-structured, technically sound, and creatively executed across media (e.g., drawings, models, animations, photography, scripts). Demonstrates originality, clarity, and strong conceptual development. Documentation is thorough and professional.
A-	Work is strong and well-presented, with minor gaps in execution or conceptual depth. Demonstrates good understanding and creativity. Documentation is clear but may lack full detail.
B	Work meets expectations with some creative or technical merit. Execution may be uneven or lack refinement. Documentation is present but not comprehensive.
C	Work is functional but lacks coherence, depth, or clarity. Limited creativity or technical fluency. Documentation is minimal or poorly organized.
D	Work is underdeveloped or poorly executed. Limited engagement with the assignment brief. Documentation is incomplete or missing key components.
F	No submission or work fails to meet basic standards. No documentation provided.

Major Assignments – Midterm (30%) & Final (40%)

A	Project integrates multiple workflows seamlessly. Shows deep insight, strong collaboration, and a compelling design narrative. Documentation is detailed, reflective, and professionally presented.
A-	Project is well-executed with minor gaps in integration or communication. Documentation is solid but may lack depth in reflection or clarity in presentation.
B	Project meets basic requirements with some creative or technical merit. Collaboration is evident but uneven. Documentation is adequate but lacks polish.
C	Project is functional but lacks coherence or depth. Collaboration is limited. Documentation is incomplete or unclear.
D	Project is underdeveloped or poorly executed. Collaboration is weak or absent. Documentation is minimal or missing key components.
F	No submission or project fails to meet basic standards. No documentation provided.

COURSE FORMAT

Teaching Days
Students must attend F2F teaching during these teaching hours.
Schedule: Tuesdays 9:30am – 12:15pm
Venue: ARC G01

Group Work
1. Students will work in groups on their major assignments requiring presentations.
2. Students are encouraged to share references, and collaborate on problem solving efforts, however, individual literacy and knowledge retention is required.

Assignments
1. Assignments will be given throughout the course to translate lecture and learning materials into practical "hands on" learning experiences.
2. Assignments shall be submitted via Blackboard on time.

Weekly Quiz
1. There are very quick weekly quizzes. These will be a mix of written (essay style questions) and "fill in the blank" that demonstrate an understanding of the previous week's activity.
2. Quizzes will be based on assigned readings, assignments, and material covered within course lectures/demonstrations.

REQUIRED READINGS

McNeel Python Wiki: http://wiki.mcneel.com/developer/python
Rhinoceros Tutorials: http://www.rhino3d.com/learn
Lyons, John. (1977) Semantics. Cambridge: Cambridge UP, 1977. Print.
ISSA, Rajaa, Essential Mathematics for Computational Design
Bandur, Markus. Aesthetics of Total Serialism: Contemporary Research from Music to Architecture.
Lynn, Greg. Animate Form. New York: Princeton Architectural, 1999. Print.
Gramophone, Film, Typewriter: Friedrich Kittler
Here/There: Telepresence, Touch, and Art at the Interface: Kris Paulsen
Programmed Visions: Software and Memory: Wendy Hui Kyong Chun

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
In any kind of learning activity or assessment that will be counted towards the final course grades (or used for evaluating attainment of the desired learning outcomes), students are not allowed to submit work which is produced with the collaboration of or supported by the use of any AI tools (e.g. ChatGPT)*.

Improper/unauthorized use of AI tools in learning activities and assessments will constitute acts of academic dishonesty and will be handled according to the University's Procedures for Handling Cases of Academic Dishonesty. In case of queries, students should seek advice from the course teacher.

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 2: 6 January 2026 (Tuesday) – 21 April 2026 (Tuesday)

WEEK 01		
06.01	**Digital Environments and Drawing**	
WEEK 02		
13.01	**Surface Modeling Methods**	
WEEK 03		
20.01	**Synthesis Methods – 3D to Reality**	
WEEK 04		
27.01	**Computational Design**	
WEEK 05		
03.02	**Computer Languages**	
WEEK 06		
10.02	**Variables and Operators**	
WEEK 07		
17.02	***Lunar New Year Vacation***	*No Class*
WEEK 08		
24.02	**Data and Lists**	
WEEK 09		
03.03	***Reading Week***	*No Class*
WEEK 10		
10.03	**Patterns**	
WEEK 11		
17.03	**Loops and Conditional Statements**	
WEEK 12		
24.03	**Exploring Tools and Applications**	
WEEK 13		
31.03	**Synthesis**	
WEEK 14		
07.04	***Ching Ming Festival***	*No Class*
WEEK 15		
14.04	**Automation Technology / Robotics / AI Tools**	
WEEK 16		
21.04	**Final Presentations**	

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

Written Feedback to Students

Term:	____________________	**Grade:**	____________
Course Code:	____________________		
Review:	____________________		
Tutor:	____________________		
Student Name:	____________________		
Student ID:	____________________		

Feedback from Course Instructor:

<u>Achievements:</u>
<u>Challenges:</u>