THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY

# MATH 2001: Foundation of Mathematics

**Course Outline - 2026-27 Fall Term**

## 1. Course Information

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|---|---|
| **Credits** | 2 |
| **Instructor** | Prof. Qingyuan Jiang |
| **Email** | jiangqy@ust.hk |
| **Office** | Room 3471, Department of Mathematics |
| **Office hours** | By appointment |
| **Course platform** | Canvas; announcements, materials, submissions, marks, and feedback will be posted there. |
| **Prerequisites** | Level 5 or above in HKDSE Mathematics Extended Module M2 OR MATH 1012 (prior to 2025-26) OR MATH 1013 OR MATH 1020 OR MATH 1023 |

**Class meetings:**

| Section | Day and Time | Venue | Instructor | Quota |
|---|---|---|---|---|
| L1 | Wed and Fri, 13:30–14:50 | Lecture Theater A | Prof. Qingyuan Jiang | 140 |
| T1A | Wed, 17:00–17:50 | Room 4579, Lift 27–28 | ZONG, Shuai | 35 |
| T1B | Fri, 09:00–09:50 | Room 2504, Lift 25–26 | HU, Yang | 35 |
| T1C | Tue, 18:00–18:50 | Room 5402, Lift 17–18 | JIANG, Linfang | 35 |
| T1D | Thu, 15:30–16:20 | Room 1527, Lift 22 | LI, Ka Ki | 35 |

Teaching assistants have not yet been assigned; their names, contact details, and the first tutorial arrangements will be announced on Canvas.

## 2. Course Description and Objectives

This course introduces foundational concepts and rigorous reasoning in mathematics that are essential for intermediate- and upper-level mathematics courses, especially in pure mathematics. It aims to strengthen students' conceptual and logical understanding, develop their ability to read and write mathematical proofs, and improve their mathematical communication.

Tentative content includes logic, sets, functions and cardinality, proof techniques, number systems, integers and polynomials, inequalities, elementary number theory, limits, and continuity. The order and emphasis may be adjusted according to the pace and needs of the class.

## 3. Intended Learning Outcomes (ILOs)

By the end of this course, students should be able to:

**ILO1:** Explain and communicate foundational mathematical concepts, including logic and logical arguments, sets, functions, cardinality, counting principles, equivalence relations, and number systems.

**ILO2:** Select and apply appropriate proof methods, including direct proof, proof by contrapositive, proof by contradiction, exhaustion, and mathematical induction.

**ILO3:** Read and analyze mathematical statements and proofs, identifying hypotheses, conclusions, logical dependencies, and gaps.

**ILO4:** Independently construct and communicate rigorous mathematical proofs in a precise, logical, and cohesive manner.

**ILO5:** Prepare clear, well-organized mathematical documents using LaTeX and appropriate mathematical notation.

## 4. Teaching and Learning Activities

| Activity | How It Supports Learning | Mapped ILOs |
|---|---|---|
| Lectures and worked examples | Introduce definitions and results, model proof strategies, analyze examples and counterexamples, and develop precise mathematical language. | ILO1–ILO4 |
| Tutorials | Provide guided problem solving, discussion of common difficulties, comparison of proof approaches, and practice in critiquing arguments. | ILO1–ILO4 |
| Independent reading, problem sets, and LaTeX writing | Consolidate concepts through sustained practice and develop independence, proof-writing fluency, and mathematical presentation. | ILO1–ILO5 |

## 5. Assessment and Grading

**Criterion-referenced grading.** Letter grades reflect demonstrated achievement of the course ILOs and the standards described in the assessment rubrics and final grade descriptors. Grades will not be assigned using a curve or predetermined proportions of students, and examination or course marks will not be rescaled to produce a target distribution.

| Assessment Task | Weight | Due Date or Period | Mapped ILOs |
|---|---|---|---|
| Homework | 20% | Regularly throughout the term | ILO1–ILO5 |
| Midterm examination | 30% | One regular class meeting in Weeks 6–8; exact date to be announced on Canvas | ILO1–ILO4 |
| Final examination | 50% | Fall examination period; scheduled by the Academic Registry | ILO1–ILO4 |
| **Course total** | **100%** | | |

**Homework.** There will be regular problem sets. Each homework must be submitted through Canvas before the deadline as either a clearly handwritten and scanned PDF or a LaTeX-typeset PDF. Twenty percent of the mark for each homework assesses LaTeX typesetting and presentation; this portion is available only for solutions typeset in LaTeX. Accordingly, a handwritten submission can earn at most 80% of the marks for that homework. Full credit for typesetting requires a readable layout, consistent and appropriate notation, and well-organized solutions.

**Examinations.** The final examination is cumulative. Both examinations are closed-book, and no electronic devices or generative AI tools are permitted. Detailed coverage and arrangements will be announced on Canvas.

**Missed examinations.** Students who cannot attend an examination must notify the instructor at the earliest practicable opportunity and follow the applicable University procedures. No make-up examination, reweighting, or other alternative arrangement is automatic. Any approved arrangement for a missed midterm will be determined in accordance with University requirements. Absence from the final examination, including any deferred or make-up examination, is governed by University and Academic Registry procedures.

## 6. Assessment Rubrics

**Homework rubric.** Each homework is assessed according to the following criteria.

| Criterion | Weight | Standard |
|---|---|---|
| Mathematical accuracy and conceptual understanding | 35% | Correct use of definitions and results, correct conclusions, and appropriate treatment of relevant cases. |
| Logical rigor and completeness | 35% | Valid reasoning; claims, assumptions, quantifiers, and intermediate steps are adequately justified; arguments contain no substantive gaps or circular reasoning. |
| Mathematical communication and organization | 10% | Solutions are logically structured, readable, and expressed using precise notation and mathematical language. |
| LaTeX typesetting and presentation | 20% | Layout is readable and well organized; notation and mathematical environments are used consistently and appropriately. This portion is available only for solutions typeset in LaTeX; handwritten submissions receive no marks for this criterion. |

**Examination rubric.** Unless a question specifies a different allocation, midterm and final examination solutions are assessed according to the following criteria.

| Criterion | Weight | Standard |
|---|---|---|
| Mathematical accuracy and conceptual understanding | 40% | Correct interpretation of the problem, correct use of definitions and results, and correct conclusions. |
| Method, logical rigor, and completeness | 40% | An appropriate proof strategy or method, valid deductions, sufficient justification, and treatment of relevant cases. |
| Mathematical communication | 20% | Clear organization, precise notation and terminology, and a coherent written argument. |

Across these criteria, excellent work is correct, complete, rigorous, and clearly presented; good work is essentially correct and logically sound with only minor errors, omissions, or presentational weaknesses; satisfactory work shows relevant understanding and meaningful progress but contains substantial errors, gaps, or imprecision; and insufficient work shows little relevant progress, relies on unsupported assertions, or displays fundamental misconceptions.

## 7. Final Grade

| Grade | Short Description | Elaboration on Subject Grading Description |
|---|---|---|
| A | Excellent Performance | Demonstrates comprehensive mastery of the concepts and proof techniques taught in the course. Constructs accurate, complete, and rigorous arguments and communicates mathematical ideas with exceptional precision and coherence. Is well prepared for further study in advanced mathematics. |

| Grade | Short Description | Elaboration on Subject Grading Description |
|---|---|---|
| B | Good Performance | Demonstrates strong understanding of most concepts and proof techniques. Arguments are generally correct, rigorous, and clearly presented, with only minor errors, omissions, or difficulty with subtler material. |
| C | Satisfactory Performance | Demonstrates adequate understanding of the core material and can solve routine problems and construct basic proofs. Work nevertheless contains recurring gaps, errors, or imprecision in reasoning or communication. Meets the essential learning outcomes. |
| D | Marginal Pass | Demonstrates only threshold and fragmentary understanding. Can complete some elementary arguments but has substantial difficulty applying proof techniques, justifying claims, or communicating reasoning coherently. Meets the learning outcomes only minimally. |
| F | Fail | Demonstrates insufficient understanding of the core material and cannot reliably use basic definitions or proof methods. Arguments are generally incorrect, unsupported, or incoherent and do not meet the essential learning outcomes. |

## 8. Course Policies

**Generative AI.** Generative AI tools may be consulted for ideas, explanations, and hints on homework. **Any such use must be disclosed in the submission by naming the tool and briefly describing how it was used. Students must independently understand and write their submitted solutions.** Direct copying of AI-generated text, proofs, calculations, or other output is **prohibited**, and submitting AI-generated work without disclosure is **prohibited**. Students remain fully responsible for the correctness and integrity of their work. Generative AI tools are not permitted in examinations.

**Communication and feedback.** Course announcements, assessment marks, and feedback will be communicated through Canvas. Feedback will address mathematical accuracy, logical rigor, clarity of communication, and, where applicable, LaTeX typesetting. Questions about marking should be raised within five working days after release and should identify the specific point to be reviewed. This course-level timeframe does not limit any rights available under applicable University procedures.

**Late submission and resubmission.** Homework submitted after the deadline will not be accepted. Students affected by documented exceptional circumstances should contact the instructor as soon as practicable and follow the applicable University or Academic Registry procedures. Any extension or accommodation is subject to those procedures and is not automatic. Graded homework may not be resubmitted for additional credit.

**Academic integrity.** Students are expected to adhere to the University's academic integrity policy, uphold HKUST's Academic Honor Code, and maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct. Unless an assignment explicitly states otherwise, students may discuss course concepts and general strategies, but **each submitted solution must be independently reasoned and written**. Unauthorized collaboration, plagiarism, copying, obtaining or supplying unauthorized solutions, contract cheating, impersonation, and the use of unauthorized tools or materials are prohibited. **All substantive assistance and sources, including any permitted use of generative AI, must be acknowledged. Suspected breaches will be handled under the applicable University procedures.** Please refer to Academic Integrity - HKUST Academic Registry for guidance on avoiding cheating and plagiarism.

## 9. Learning Resources

- **[Q] Required:** Prof. Quoc Ho's MATH 2001 lecture notes, to be posted on Canvas. The notes present the main points of the course; lectures provide fuller explanations, examples, and discussion.
- **[B] Recommended:** Richard Hammack, *Book of Proof*, Third Edition, 2018. Freely available online from the author's website.
- **[K] Recommended:** Jonathan M. Kane, *Writing Proofs in Analysis*, Springer International Publishing, 2016. doi:10.1007/978-3-319-30967-5.
- **[H] Recommended:** Kevin Houston, *How to Think Like a Mathematician: A Companion to Undergraduate Mathematics*, Cambridge University Press, 2009. doi:10.1017/CBO9780511808258.
- **[Y] Supplementary:** Prof. Min Yan's course notes for an earlier version of MATH 2001, to be made available through Canvas.
- Further supplementary notes and references selected for particular topics will be posted on Canvas.

Students are expected to have access to a LaTeX environment for preparing typeset homework.

## 10. Tentative Weekly Schedule

The schedule below is tentative and may be adjusted according to the progress of the class and the confirmed midterm date. The midterm examination will take place during one regular lecture in Weeks 6–8.

| Week | Dates | Lecture Content |
|---|---|---|
| 1 | Sep 2, 4 | Statements, truth values, and logical connectives |
| 2 | Sep 9, 11 | Quantifiers, definitions, and theorem structure; direct proof, cases, and contraposition |
| 3 | Sep 16, 18 | Induction and contradiction; set membership, subsets, equality, and basic operations |
| 4 | Sep 23, 25 | Power sets, products, and tagged unions; set-law problem solving |
| 5 | Sep 30, Oct 2 | Functions, graphs, and composition; images, preimages, and their laws |
| 6 | Oct 7, 9 | Injectivity, surjectivity, and inverses; equivalence relations, classes, quotients, and fibers |
| 7 | Oct 14, 16 | Midterm (tentative); natural numbers and recursion |
| 8 | Oct 21, 23 | Integer arithmetic and order; construction and well-definedness of the rationals |
| 9 | Oct 28, 30 | Rational order and density; real numbers from Cauchy sequences |
| 10 | Nov 4, 6 | Arithmetic, order, and limits of the real numbers |
| 11 | Nov 11, 13 | Real completeness, subsequences, and suprema; complex numbers, fields, and rings |
| 12 | Nov 18, 20 | Formal polynomials and division; the integer Euclidean algorithm and Bézout's identity |
| 13 | Nov 25, 27 | The polynomial Euclidean algorithm and quotient fields; complex numbers as a quotient and rational functions |