



**MAT 231 (010) Introduction to Logic and Set Theory, Spring 2024**  
**9:30 PM – 10:45 AM (T Th) face to face in Tarpley 312**

**Instructor:** Kyung Il Lee, PhD

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**Office Hours:** 10:00–11:00 AM (M W), 2:20–3:20 PM (M W) and 1:50–3:50 PM (Th). Make an appointment. (<https://calendly.com/kyungil-lee/office-hours-spring-2024>) Otherwise, first come, first served.

**Disability Accommodation:** The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you have a documented disability requiring an accommodation, please contact the Academic Support Office (ASO).

Reinhardt University is committed to providing reasonable accommodations for all persons with disabilities. Therefore, if you are seeking classroom accommodations under the Americans with Disabilities Act, you are required to register with the Academic Support Office (ASO). ASO is located in the basement of Lawson Building. Phone is (770) 720-5567. To receive academic accommodations for this class, please obtain the proper ASO letters/forms.

**Course Materials:**

1. Mathematical Proofs: A Transition to Advanced Mathematics by Gary Chartrand, Albert D. Polimeni and Ping Zhang, 4th edition. (Recommended)
2. Lecture slides will be provided.

**Course Description:** This course introduces to students the foundations of logic, set theory and mathematical symbols, and the axiomatic construction of numerable number systems using Peano's Postulates and equivalence relations. The course serves as a bridge from the procedural and computational understanding of mathematics to a broad understanding encompassing logical reasoning, generalization, abstraction, axiomatic approach, and symbolical representations needed to produce formal proofs in other upper-level Mathematics courses. Topics include propositional logic, predicates and quantifiers, rules of inference, basic proof methods, naïve set theory, equivalence relations, functions, cardinality of sets, Peano's postulates, mathematical induction, numerable number systems, and modular arithmetic. *Prerequisite:* University Placement, or a grade of C or better in MAT 102, MAT 121, or MAT 221.

# Objectives & Learning Outcomes

## Conceptual Framework:

1. The Mathematics Department at Reinhardt University believes that all students should have an exposure to the ideas of science and the scientific method. This includes exposure to laboratory procedures, familiarity with some of the vocabulary of science and ability to read scientific articles in the newspaper or in popular magazines.
2. The Mathematics Department at Reinhardt University believes that all students should be familiar with the systematic development of science through history. This includes an understanding of the effects that science has had on history and that history has had on scientists.
3. The Mathematics Department at Reinhardt University wishes to convey to students that science is a continuing endeavor that will not ever be finished. This includes an introduction to the interaction of theory and observation.

## Course Relationship to Conceptual Framework:

The course will be taught using lectures and in-class problem solving activities.

## Course Learning Outcomes: As a result of passing MAT 231 a student should be able to

1. understand the basic elements of propositional logic (SLO2 and SLO3),
2. construct a simple mathematical proof using truth tables, direct proof, indirect proof and mathematical induction (SLO1, SLO2, SLO3, and SLO4),
3. understand and apply the basic elements of set theory (SLO2 and SLO3),
4. use mathematical symbols of set theory properly (SLO2 and SLO3),
5. compare the cardinality of sets (SLO1, SLO2, and SLO3),
6. apply the basic properties of relations including reflexive, symmetric, anti-symmetric and transitive, and how these relate to various types of functions and other relations (SLO2 and SLO3),
7. recognize equivalence relations and build quotient sets (SLO2 and SLO3),
8. understand and apply Peano's Postulates (SLO2 and SLO3),
9. build numerable number systems using Peano's Postulates and equivalence relations (SLO2 and SLO3),
10. understand and apply mathematical induction and modular arithmetic (SLO2 and SLO3).

## Mathematics Program Objectives: The Mathematics Program at Reinhardt University offers courses geared to

- MP01 Analyze and solve problems by using reasoning, logic and evidence, and by bringing knowledge from a wide range of mathematical areas.
- MP02 Use effective written and oral expression of mathematical concepts in the creation of a mathematical argument by recognizing a wide range of mathematical terms and vocabulary.
- MP03 Apply axiomatic systems.
- MP04 Apply mathematical research methodologies by using libraries, informational technologies, computer programming and numerical methods in order to create solutions to problems.
- MP05 Apply ethical, legal, and policy issues to Information Technology
- MP06 Create IT solutions to solve organizational problems.

## Mathematics Program Student Learning Outcomes: Taking this course, students will be able to

- SL01 Solve a word problem by applying the appropriate mathematical setup, obtaining the mathematical solution, and interpreting this solution in the context.
- SL02 Solve a theoretical problem by identifying the appropriate mathematical context, interpreting the question and the nature of the solution, and checking that the solution is correct.
- SL03 Complete a proof or produce a mathematical object that satisfies specific properties.
- SL04 Solve a problem by consulting various resources, applying appropriate technological tools, and using adequate approximations.
- SL05 Analyze how information technology affects ethical and legal issues.
- SL06 Synthesize appropriate solutions to organizations' problems.

| Math PO | Math SLO | RU SLO   |
|---------|----------|----------|
| 1       | 1        | 1, 2, 4  |
| 2       | 2        | 1 – 4    |
| 3       | 3        | 1 – 4    |
| 4       | 4        | 1 – 4    |
| 5       | 5        | 1 – 4, 7 |
| 6       | 6        | 1 – 4    |

# Course Policies & Procedures

**Academic Integrity:** All students are expected to adhere to the highest standards of academic integrity, and to abide by the Reinhardt Honor Code. Also, all students are expected to be familiar with the Reinhardt policy on academic dishonesty stated in the University Catalog and in the Student Handbook. Academic integrity and honorable behavior are essential parts of the professionalism that will be required well beyond graduation. Academic dishonesty (whose activities include plagiarism, cheating, collusion, etc.) in the class will not be tolerated and will yield a grade of F. Consequences for academic dishonesty:

- (a) State your policy for violation of academic integrity policy.
- (b) The Office of the Vice President for Academic Affairs will be notified of actions taken against students who violate the academic integrity policy, which may result in further consequences, including designation of “academic warning” on your official transcript, academic suspension, or expulsion for academic reasons.

**Attendance:** Students are required to be present at every session. No late entry and no early leave. Students who are absent for more than three class meetings will fail the course. Please arrive to class on time. Any pair of two from unexcused tardy and/or unexcused early leave will be considered one unexcused absence.

## Classroom Guidelines and Expectations:

- 1. You are expected to be courteous and respectful to all students, teachers, and guests.
- 2. Students are expected to pay attention and participate in class.
- 3. Cell phones must be turned off or to silent.
- 4. Use of any type of earbuds or headphones are prohibited.
- 5. Playing games and watching movies etc. will not be allowed.
- 6. No bathroom break.
- 7. Disregard for these guidelines may result in disciplinary action, which could include the student being excused from class and marked absent for that day to being suspended from that class.

**Method of Evaluation:** Your grade for the course will be based on the following approximate numbers and percentages:

|                    |      |
|--------------------|------|
| Two Midterm Exams: | 60%  |
| Homework:          | 10%  |
| Final Exam:        | 30%  |
| Total:             | 100% |

- \* Closed Note Exams: There will be no make-up exams without emergencies or serious schedule clashes. Appropriate evidence and/or prior notification will be required to be provided if you wish to request the weight of the missed midterm to be transferred to the final examination. No calculating devices and programs are allowed. No bathroom break is allowed.

- \* Homework: Problem sets must be written up neatly and in complete sentences, and must be in essay form. Writing assignments in incomplete sentences will receive no credit. No late homework will be accepted.

**Grading:** Final grades in this course will be based on the following scale:

A = 90%–100%, B = 80%–89.9%, C = 70%–79.9%, D = 60%–69.9%, F = 59% or Below

**For Free Tutoring and Help with Homework:** The Center for Student Success located on bottom floor of Lawson, room 035, is a free tutoring service available to all students. For appointments—go to Reinhardt webpage; click on Academics. When the next page appears, click Center for Student Success. On that screen, click Student Appointment Form. Fill out required fields and then submit. If you would prefer to call, the number is (770) 720-9232.

## University Policies

**COVID-19:** Reinhardt University's COVID-19 Policy applies to all students, faculty, staff, administration and guests. The policy is subject to changes based on conditions and guidance from CDC, state and local health experts. Current policies and procedures can be found at: <https://www.reinhardt.edu/back-to-campus>. If you have any questions, please refer to the website or contact Reinhardt University at the numbers below.

1. Campus Nurse within the Student Health Center: [studenthealthcenter@reinhardt.edu](mailto:studenthealthcenter@reinhardt.edu), (770) 720-5542 or <https://www.reinhardt.edu/nurse>.
2. Public Safety: Non-Emergency Phone: (770) 720-5789, Emergency Phone: (770) 720-5911, [publicsafety@reinhardt.edu](mailto:publicsafety@reinhardt.edu)
3. Dean of Students: [deanofstudents@reinhardt.edu](mailto:deanofstudents@reinhardt.edu), (770) 720-5540
4. Office of the Vice President for Academic Affairs: [VPAA@reinhardt.edu](mailto:VPAA@reinhardt.edu), (770) 720-9102.

**\*\* This syllabus is subject to change with announcement emails \*\***

# Tentative Schedule

| Week | Dates                         | Topic/Readings                                                                                                                                                             | Notes/Announcements         |
|------|-------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| 1    | Jan 8<br>9<br>10<br>11<br>12  | Chapter 0 Communicating Mathematics; 1.1 Describing a Set<br>1.2 Subsets, 1.3 Set Operations                                                                               |                             |
| 2    | 15<br>16<br>17<br>18<br>19    | 1.4 Indexed Collections of Sets<br>1.5 Partitions of Sets; 1.6 Cartesian Products of Sets                                                                                  | Martin Luther King, Jr. Day |
| 3    | 22<br>23<br>24<br>25<br>26    | 2.1 Statements; 2.2 Negations; 2.3 Disjunctions and Conjunctions<br>2.4 Implications; 2.5 More on Implications; 2.6 Biconditionals                                         |                             |
| 4    | 29<br>30<br>31<br>Feb 1<br>2  | 2.7 Tautologies and Contradictions; 2.8 Logical Equivalence;<br>2.9 Some Fundamental Properties of Logical Equivalence<br>2.10 Quantified Statements                       |                             |
| 5    | 5<br>6<br>7<br>8<br>9         | Review<br>Exam 1                                                                                                                                                           |                             |
| 6    | 12<br>13<br>14<br>15<br>16    | 3.1 Trivial and Vacuous Proofs; 3.2 Direct Proofs; 3.3 Proof by Contrapositive<br>3.4 Proof by Cases; 3.5 Proof Evaluations                                                |                             |
| 7    | 19<br>20<br>21<br>22<br>23    | 4.2 Proofs Involving Congruence of Integers; 4.3 Proofs Involving Real Numbers<br>4.4 Proofs Involving Sets; 4.5 Fundamental Properties of Set Operations                  |                             |
| 9    | 26<br>27<br>28<br>29<br>Mar 1 | 4.6 Proofs Involving Cartesian Products of Sets<br>5.1 Counterexamples, 5.2 Proof by Contradiction                                                                         |                             |
| 8    | 4<br>5<br>6<br>7<br>8         |                                                                                                                                                                            | Spring Break                |
| 10   | 11<br>12<br>13<br>14<br>15    | 5.3 A Review of Three Proof Techniques<br>5.4 Existence Proofs; 5.5 Disproving Existence Statements                                                                        |                             |
| 11   | 18<br>19<br>20<br>21<br>22    | Review<br>Exam 2                                                                                                                                                           |                             |
| 12   | 25<br>26<br>27<br>28<br>29    | 6.1 The Principle of Mathematical Induction<br>6.2 A More General Principle of Mathematical Induction;<br>6.3 The Strong Principle of Mathematical Induction               | Good Friday                 |
| 13   | Apr 1<br>2<br>3<br>4<br>5     | 6.4 Proof by Minimum Counterexample                                                                                                                                        | Spring Day                  |
| 14   | 8<br>9<br>10<br>11<br>12      | 9.1 Relations; 9.2 Properties of Relations; 9.3 Equivalence Relations<br>9.4 Properties of Equivalence Classes; 9.5 Congruence Modulo $n$ ;<br>9.6 The Integers Modulo $n$ |                             |
| 15   | 15<br>16<br>17<br>18<br>19    | 10.1 The Definition of Function; 10.2 One-to-one and Onto Functions<br>10.3 Bijective Functions; 10.4 Composition of Functions; 10.5 Inverse Functions                     |                             |
| 16   | 22<br>23<br>24<br>25<br>26    | Review<br>11:15 a.m. – 2:15 p.m.                                                                                                                                           | Last day of classes         |
| 17   | 29<br>30<br>May 1<br>2<br>3   |                                                                                                                                                                            | Final Week (04/25–05/01)    |

Final Schedule: <https://www.reinhardt.edu/wp-content/uploads/2023/10/Final-Exam-Schedule-Spring-2024.pdf>