

## INTRODUCTION TO MATHEMATICAL REASONING (FALL 2019)

**Course.** MATH 01:640:300 (TF 12:00-1:20 pm, ARC 108)

**Instructor.** Dr. P. H. Tiep

**Contact information.**

Office: Hill Center 720, Tel: (848) 445-6915

email: [tiep@math.rutgers.edu](mailto:tiep@math.rutgers.edu)

webpage: <http://www.math.rutgers.edu/~pht19>

**Learning Assistant.** Leen Kharboutli, [leen.kharboutli@rutgers.edu](mailto:leen.kharboutli@rutgers.edu)

**Office hours.** Tuesday 2:30 – 3:20pm, Wednesday 11:00 – 11:50am, Friday 2:30 – 3:20pm. You are also welcome to come to my office at any time if I am in and available.

**Textbook.** ‘A Transition to Advanced Mathematics’, Smith, Eggen and St. Andre, 8th ed Brooks/Cole, ISBN 0-534-38214-2. After class, read your notes and the textbook material thoroughly before attempting the assigned problems.

**Description.** Fundamental abstract concepts common to all branches of mathematics. Special emphasis placed on ability to understand and construct rigorous proofs.

Prerequisites: CALC2 or or permission of the department.

**Objectives.** This course is intended to help prepare students for high level mathematical reasoning and more generally, to help students transition from computational math courses to more abstract courses based on reading and writing mathematical proofs. Our objective is to learn the language of mathematics, to learn to read and write structured mathematical proofs, to be able to judge if a proof is correct or incorrect and to defend a correct mathematical argument. The subject matter chosen for this task is basic number theory, set theory and some combinatorics. However, the subject matter is not the emphasis, it is more a vehicle to learning and practicing the techniques.

**Homework.** Homework assignments will be posted on my webpage. Homework (stapled) will be collected on the due date in class, and will be graded, with one part of credit given for completeness and another part for selected problems. Graded homework can be picked up one week later in class at the end of class, or during my office hours. Homework past the due date is not accepted.

**Learning Assistants Program and Workshops.** This section has learning assistants who are part of a university wide program that is in partnership with the Rutgers Learning Centers. The objectives of this program are to engage students in the process of teaching and learning, to encourage students to work collaboratively and to communicate their findings.

Students will be able to interact with the undergraduate Learning Assistant at weekly workshops, run as part of Friday’s classes starting the second week of the semester, where students work on problems together. Workshop problems will be distributed the day before the workshop; students must bring a printed copy of them to the workshop to work on them.

**Exams (subject to change).** There will be **one in-class (midterm) exam** given on **Oct. 22** (Tuesday). The final exam is comprehensive and given on **Dec. 19** (Thursday), 12:00-3:00 pm. All the exams are given in the usual classroom.

The ONLY permissible reason for make-up exams is based on verifiable medical grounds or religious holidays. In the former case, written statements (accompanied by phone numbers) of attending physicians **and** letters from the Dean of Students' office, are required to prove genuine medical emergencies. In the latter case, the instructor must be informed at least two weeks ahead of the exam date.

#### **Grade.**

Total: 30% (midterm) + 40% (final) + 25% (homework) + 5% (workshop participation) = 100%.

Extra credit up to 2% for typing homework.

**Important.** Your written work should be neat. Show all your work. Answers with no work and/or no explanations will receive no credit. Please remember that the instructor is here to help you, so never afraid to ask for help.

Students are expected to attend every scheduled class and to be familiar with the University Class Attendance policy. It is the student's responsibility to keep informed of any announcements, syllabus adjustments or policy changes made during scheduled classes.

Students are expected to behave in accordance with the Code of Academic Integrity, see <http://academicintegrity.rutgers.edu/academic-integrity-policy>

The university is fully committed to compliance with the Americans with Disabilities Act; policies and procedures are indicated at <http://ods.rutgers.edu>. Students who wish to request special accommodations must present a Letter of Accommodations to the instructor as early in the term as possible.

#### **Student-Wellness Services.**

- **Just In Case Web App** <http://codu.co/cee05e>

Access helpful mental health information and resources for yourself or a friend in a mental health crisis on your smartphone or tablet and easily contact CAPS or RUPD.

- **Counseling, ADAP & Psychiatric Services (CAPS)** (848) 932-7884

17 Senior Street, New Brunswick, NJ 08901 / [www.rhscaps.rutgers.edu/](http://www.rhscaps.rutgers.edu/)

CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

- **Violence Prevention & Victim Assistance (VPVA)** (848) 932-1181

3 Bartlett Street, New Brunswick, NJ 08901 / [www.vpva.rutgers.edu/](http://www.vpva.rutgers.edu/)

The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

- **Disability Services** (848) 445-6800

Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / <https://ods.rutgers.edu/>

The Office of Disability Services works with students with a documented disability to determine the eligibility of reasonable accommodations, facilitates and coordinates those accommodations when applicable, and lastly engages with the Rutgers community at large to provide and connect students to appropriate resources.

- **Scarlet Listeners** (732) 247-5555 / <http://www.scarletlisteners.com/>

Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.

**Topics, in approximate order of sequence (to be updated).**

1. *Introduction. Sets and operations between sets.* (Text Sections 2.1, 2.2 and Appendix on Sets, Number systems and Functions)
2. *Direct proof, proof by contradiction.* (Text Section 1.4)
3. *Number systems: natural numbers, integers, rational numbers, real numbers, even and odd integers.* (Text Appendix on Sets, Number systems and Functions)
4. *Methods of proof: ‘Sketch’ proofs, proving a bi-conditional statement, disproving by counterexamples, proof by cases, constructive proof, existential proof.* (Text Section 1.4, 1.5, 1.7)
5. *Logic and symbolic language.* (Text Chapter 1)
6. *Symbolic language and quantifiers.* (Text Section 1.3)
7. *Propositions and connectives.* (Text Section 1.1)
8. *Quantifiers.* (Text Section 1.3, 1.6, 1.7)
9. *Writing in symbolic language, combining quantifiers, negating compound statements.* (Text Section 1.6)
11. *Truth tables, ‘And’, ‘Or’, negation, equivalence, implication.* (Text Section 1.4)
12. *Contrapositive and converse.* (Text Sections 1.2, 1.5, 1.7)
13. *Proof by contradiction, when is a theorem proven?* (Text Section 1.5)
14. *Proofs involving properties of numbers: divisibility, the division algorithm, integer equations, prime numbers and composite numbers, Mersenne’s primes, irrationality of  $\sqrt{2}$ .* (Text, Sections 1.4, 1.8)
15. *Mathematical induction, inductive sets, proofs by induction.* (Text Section 2.4)
16. *The well-ordering property of  $\mathbf{N}$  and the method of smallest counterexamples.* (Text Section 2.5)
17. *Relations on a set.* (Text Section 3.1)
18. *Equivalence relations, equivalence classes.* (Text Section 3.2)
19. *Partially ordered sets.* (Text Section 3.5)
20. *Partitions, a partition of  $\mathbf{C}$ ,  $\mathbf{Q}$  as a set of equivalence classes.* (Text Section 3.3)
21. *Congruences.* (Text Section 3.4)
22. *Functions and their properties, injectivity and surjectivity.* (Text Section 4.2, 4.3)
23. *Inverse functions.* (Text Section 4.4)
24. *Infinite sets. Euler’s and (little) Fermat’s Theorems. Real numbers as decimals.* (Text Section 5.2)
25. *Countable sets, countability of  $\mathbf{Q}$ , uncountability of  $\mathbf{R}$ , and the continuum hypothesis.* (Text Section 5.3)
26. *Comparability of cardinal numbers and the axiom of choice.* (Text Sections 5.4, 5.5)