Introduction to the Theory of Groups: Math 322
September 2019

Time: TuTh 1400:1530
Place: LSK 460
Instructor: Vinayak Vatsal (Math 322c)
Instructor email: lastname at math-ubc-ca (use dots instead of dashes)
Office hours: Tuesday 1300:1350 and online on Piazza, or by appointment

Objectives: This course is an introduction to modern algebra, which, together with analysis, is one the two basic building blocks of all mathematics. Groups are the first examples of abstract algebraic objects, and this course is focused on their properties. Students will learn how to deal with multiplication in abstract groups, to manipulate abstract quantities, and to prove theorems about general abstract groups. Students will be expected to work in situations where examples are hard to find, and often misleading. By the end of the class, students should be sufficiently familiar with groups to move on to the next level of algebraic complexity as embodied by fields and rings. **Students should be aware that the nature of the material will be quite different from other courses they may have taken. Clear and precise mathematical writing is a will be required — all students should be comfortable writing moderately complex proofs.**

Pre-requisites: Either (a) a score of 68% or higher in one of MATH 223, MATH 310 or (b) one of MATH 152, MATH 221, MATH 223 and a score of 80% or higher in MATH 220

Co-requisites: There are no formal co-requisites, but Math 312 (Introduction to Number Theory) would be very helpful. It is strongly recommended that you take Math 312 in conjunction with this course. The material is closely connected, and your understanding of both classes will be improved.

Materials: We will primarily follow the course text book **Abstract Algebra**, by **Dummit and Foote** (third edition, available from the bookstore). There are other editions of this book that you can choose, but all references to the text in class and in the homework will be to the third edition.

Other references include *An Introduction to the Theory of Groups*, by Rotman (this book is available at no cost, online from Springerlink, accessible through the UBC Library), and *Topics in Algebra*, by Herstein.

Homework: There will be weekly homework together with weekly readings, and regular in-class clicker questions. I recommend that you keep up with the readings, and read in advance of class. All homework will be taken from the textbook. If you are using some book, it is your responsibility to find the homework questions.

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Homework submissions **must be typeset** and uploaded to Canvas in PDF format. I recommend using LaTex, as it is the standard system, is free, and produces the most readable mathematics. It is also the standard means to write mathematics in Piazza. Some of you may have used LaTeX in other courses as well.

You are of course free to use any typesetting system of your choice, but any difficulty you may experience in producing intelligible mathematics is your own responsibility.

The homework submission window will close at **midnight on Wednesdays**. No late homework will be accepted.

For those of you who have never seen LaTeX before, I have assembled a solution template and some online resources in Homework Set 0 on the course Canvas page.

Resources: There is a course Piazza page on Canvas. I will check in periodically and answer questions, to the extent that it is possible. But owing to the complicated nature of the material, it might be easier to come to office hours or to make an appointment if the set time is inconvenient.

Exams: One midterm, in class on October 24, and a final exam with date set by the University.

Assessment: 10% Clicker, 15% homework, 30% midterm, 45% final.

Syllabus and course schedule

Week 1: September 6. Preliminaries — Basics, properties of the integers, the integers modulo N. (Read text, 0.1 - 0.3)

Week 2: September 10, 12. Preliminaries continued; Basic axioms and examples, Examples of groups (Sections 1.1-1.5)

Week 3: September 17, 19. Homomorphisms and isomorphisms, Group actions (1.6-1.7)

Week 4: September 24, 26. Subgroups: definitions and examples; centralizers, normalizers, stabilizers, kernels. Cyclic groups and subgroups; subgroup generated by a subset (2.1-2.4)

Week 5: October 1, 3. Quotient groups and homomorphisms: definitions, examples; Lagrange's theorem; isomorphism theorems (3.1-3.3, 3.5)

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Week 6: October 8, 10. Transpositions and the alternating group; groups actions; permutation representations (3.5, 4.1)

Week 7: October 15, 17. Cayley's theorem; Class equation (4.2 - 4.3)

Week 8 October 22, 24. Automorphisms (4.4). Midterm Oct 24.

Week 9: Oct 29, 31. Sylow theorems (4.5)

Week 10: Nov 5, 7. The simplicity of the alternating groups. Direct products. (4.6, 5.1)

Week 11 Nov 12, 14. The fundamental theorem of finitely generated abelian groups (5.2)

Week 12 Nov 19, 21: Groups of small order; recognizing direct products (5.3, 5.4)

Week 13 Nov 26, 28: Semidirect products (5.5)

University Policies

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