

# MATH 4140/5140: Abstract Algebra 2

MWF 11:15-12:05, MCOL E 158

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Office hours: M 12:30 - 2 pm, F 10 - 11 am

Course website: <https://math.colorado.edu/~mayr/teaching/math4140spring24/>

**Course description:** Representation theory is a powerful tool to investigate groups with techniques from linear algebra and ring theory. First we represent a given abstract group as a group of invertible matrices under multiplication. Having these matrices act on vector spaces allows us to gain remarkable insights in the structure of the group. For some deep results in group theory the only known proofs require representation theory.

The goal for this course is to cover the underlying basics of ring theory, develop essential results of representation theory of finite groups over the complex numbers and give some applications following this outline:

- (1) Group algebras and modules
- (2) Decomposition of modules: Maschke's Theorem, Schur's Lemma
- (3) Structure of group algebras: Wedderburn Artin-Theorem
- (4) Characters: orthogonality relations
- (5) Induced representations
- (6) Normal subgroups
- (7) Burnside's Theorem that groups of order  $p^a q^b$  are solvable

**Prerequisites.** Math 3140 Abstract Algebra 1 or a similar algebra course

**Assignments.** Every Monday I will post homework problems on the website. Please submit solutions as pdf on Canvas by the following Monday midnight.

Late homework will not be accepted. Instead the 3 lowest homework scores will be dropped and not count towards the final grade.

You are allowed and encouraged to discuss your assignments with others. However I ask you to first try to solve your problem on your own. If you get seriously stuck, discuss it with your colleagues, me, etc. In any case write up the solutions that you hand in alone.

There will be 2 midterm exams in class (Wednesday, February 21 and Monday, April 8) as well as a final exam (Sunday, May 5, 7:30 - 10 pm).

Cheating on your assignments may result in a grade of 0. Please find the honor code of CU Boulder here <http://honorcode.colorado.edu/>

**Grading.** Your final grade will be determined by the scores of your homework, midterms, and final exam. They will be combined using the following weights:

Homework: 40%

Midterms: 30%

Final exam: 30%

**Texts.** We will mainly follow

- G. James and M. Liebeck. Representations and characters of groups, second edition, Cambridge University Press, 2001. (available electronically via the CU library)

For supplementary reading I suggest

- M. Isaacs. Character theory of finite groups. Dover, 1994.

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<http://www.colorado.edu/policies>