MATH 410 Permutation Groups
FALL 2021

Lecture: MWF 12–12:50, Small 235
Instructor: Eric Swartz
Pronouns: he/him/his
E-mail: easwartz@wm.edu
Office hours: MWF 11–12, MWF 1–2, and by appointment, Jones 133. I will usually be around after class in the afternoons MWF. If my door is open, feel free to stop in!
Course homepage: We will use **Blackboard** as our course homepage.
Important dates: Sep 10 (Add/drop deadline), Nov 1 (Withdraw deadline)

POLICIES IN THIS SYLLABUS ARE CONTINGENT ON CLASSES BEING HELD IN-PERSON AND ARE SUBJECT TO CHANGE IN THE EVENT OF CLASSES BEING HELD REMOTELY.

Catalog Description: Although it is one of the oldest topics in group theory, the theory of permutation groups continues to play an important role in modern group theory both by providing concrete representations of abstract groups and by its application to the symmetry of combinatorial structures. Topics will include blocks and primitivity, multiply transitive groups, and applications of these ideas to graphs and related structures.

Prerequisites: MATH 307 Abstract Algebra

Textbook: None! You are not to use any resources except those provided to you by this class.

COLL 400 info: The COLL 400 capstone experience will require students to take initiative in synthesis and critical analysis, to solve problems in an applied and/or academic setting, to create original material or original scholarship, and to communicate effectively with a diversity of audiences. Students can fulfill this requirement through upper-level seminars, independent study and research projects, and Honors projects, as deemed appropriate by departments, programs, or schools. COLL 400 may but need not have an interdisciplinary focus as students can synthesize material within as well as across disciplines. COLL 400 capstone experiences must be at least 3 credits, and normally be taken in the senior year.

Grading:

In-Class Participation:	30%
Written Assignments:	15%
Portfolio:	25%
Final Project:	25%
Summary of Final Project for Non-Experts:	5%

Final letter grades are assigned using the scale: A 93–100, A- 90–92, B+ 87–89, B 83–86, B- 80–82, C+ 77–79, C 73–76, C- 70–72, D+ 67–69, D 63–66, D- 60–62, F <60
This scale is not rigid! Lower cutoffs (and slightly different weights that are beneficial to a student) are often used.

In-Class Participation: The majority of time spent in class will *not* be spent on lectures. Instead, a list of problems will be assigned. Some class time may be devoted to working on these problems in groups, but the majority of class time will be devoted to student presentations (at the board) of these problems.
When solutions are presented at the board by others, students are expected to be actively involved. The class, as a whole, will be the judge of correctness of an argument. Students are encouraged and expected to be critical *in a respectful manner* of the arguments they are presented. For example, rather than stating, "That's wrong," (etc.), a student should ask a question of the presenter, such as, "Can you explain line xx?" or "How can you conclude A from B?" Pictures of (or notes for) presentations done in class will be posted on Blackboard, so students are encouraged to pay active attention to the argument (as opposed to copying down notes word-for-word).
It's also important to allow people to fix any issues brought up in their proof on their own, so corrections should not immediately be offered by those not presenting a proof! If a mistake is found in a proof, the presenter should have time to think about it – either up at the board or after class on their own time – to try to overcome the issue. So, naturally, some arguments will be left incomplete at times, even if some in the classroom know how to finish it.
Presenting material in front of others naturally can be stressful. Moreover, *everyone* makes mistakes sometimes, and (while students are expected to have thought carefully about what they are presenting) it is inevitable that mistakes or omissions will be made in class presentations. Mistakes are often as useful (or even more so!) than correct answers, as long as they are made in a respectful environment. Furthermore, not everyone views a topic from the same perspective, so questions should also be answered from a similarly respectful perspective! In some circumstances, I am willing to review some written work ahead of time or watch some presentations in my office (with only me as an audience). The goal, however, is to foster a collaborative and supportive environment in the classroom.
Participation grades are based *both* on board presentations and active participation as a spectator. Moreover, while getting an argument completely correct at the board is better than writing down things that are incorrect, *presenting an argument of any sort is more valuable than not.* For this reason, students who have not participated as often or recently

will be given the first opportunity to present (if they are so inclined). The participation grade will (necessarily) be somewhat subjective in the eyes of the instructor. However, I *want* everyone to get a perfect (or near perfect) participation score, and I will always be willing to divulge what grade I would give you if the class ended that day at any time during the semester.

Written Assignments: When a new set of problems is assigned, some problems will be marked with an asterisk. These problems are not eligible to be presented in-class. Instead, the proofs of these must be typed up using LaTeX (see below). You are encouraged to submit attempts at these problems as soon as you can after they are assigned. Incorrect proofs will be returned for you to repair, and you will typically not receive a grade from me until they're completely correct. The final due date for each problem will be the class date *after* we are finished talking about the topics of that particular problem set; for example, if we finish talking about the problems on a Wednesday, then the written problems will be due on Friday (assuming class is held on Friday). While this means the amount of time for a set of problems is somewhat variable, (1) you will always have at least one week in real time to complete a written assignment, and (2) you will always have at least two days (real time) notice that the written problems will be due. Your final homework grade will be based on the number of *completely correct* proofs handed in on time, *regardless of how many incorrect versions you turned in previously.* Partial credit may be given in some circumstances, but most problems will be scored as either 0 or 1!
Don't wait until the day before a problem is due to make your first attempt! Especially early in the semester, as you are getting used to writing proofs, problems may take multiple tries to get completely correct! Turn in an attempt as soon as possible after it's assigned so that you can get feedback. Late homework will only be accepted under truly extraordinary circumstances (e.g., major surgery). In order to be counted correct, a proof must be written in clear, correct English.
While you may discuss the problems with your classmates (and you are in fact encouraged to do so!), copying someone else's work is strictly prohibited and will result in scores of zero for *everyone* involved. In particular, you may not use another student's final work as a "model," and you may not allow other students to study your final work. Everyone must hand in final proofs separately. Needless to say, copying or adapting a proof from another source (e.g., book or internet) is strictly prohibited as well.

Homework Policy: PDF files are to be emailed directly to me at easwartz@wm.edu. You should name the file you are turning in starting with "LastnameFirstname" in the filename; for example, `SwartzEric_Set1.pdf` or `SwartzEric_410HWSep15`. (Name the file whatever you want, but *always* start with "LastnameFirstname"!) **You should either omit or mark as graded/correct problems that you have already gotten correct.** HW that is turned in by 12 PM ET on a given weekday will be graded that day (or very shortly thereafter). HW turned in at other times may not be graded until the next "batch" (but may be graded sooner, if possible). If HW is due on a given date, I will accept it if it is turned in by 11:59 PM ET that day (but I might not grade it until the next day's "batch"). **Try to turn in HW by 12 PM ET on weekdays if you can!**

Portfolio: Students are expected to type up solutions to all problems presented in class using LaTeX (see below). *All problems must be typed up by each student, individually. Sharing and copying files is strictly forbidden.* There will be portfolio checks throughout the semester at the beginning of each month, but a grade will only be assigned at the end of the semester. The portfolio will be judged on completeness and correctness, and it is due at 12 PM on Monday, December 20.

Final Project: Each student will conduct a final project that will be conducted over the course of the semester, culminating in an original paper, at least 10–15 pages long, that satisfies the Mathematical Writing Requirement. The project could be on a specific topic in the field of permutation groups, an application of the theory of permutation groups to another field or problem, or a discussion of how to present advanced concepts from this course to a broader audience. The project could be a synthesis and explanation of current results in a particular area to a broader audience or (in exceptional cases) it could form the beginning of an undergraduate research project. The papers should be written in a style that is appropriate for an audience of undergraduate math majors. **In addition, students will be asked to provide a short summary of their work for an audience of non-experts, e.g., a "scientifically literate" audience.** Projects will be graded both on their mathematical content and readability, and they will be due at 12 PM on Monday, December 20.

LaTeX: Your homework assignments must be typeset using LaTeX. Being able to use this software is a useful skill to have, and the programs are available for free. Here are some sample options:

Windows: MikTex `http://miktex.org/download`
Mac: MacTex `http://tug.org/mactex/`
Linux: Kile (if you use Linux, I'm assuming you will know how to find it)
You may also use the online editor available at `https://www.overleaf.com/`. Simply sign up for free, start a new project, and paste the text from "sample.tex" into the source side. It is easy to google commands/techniques that you don't know, but a list of common symbols is available at `http://cklixx.people.wm.edu/TeX-symbol.pdf`

ADA Accommodation: William & Mary accommodates students with disabilities in accordance with federal laws and university policy. Any student who feels they may need an accommodation based on the impact of a learning, psychiatric, physical, or chronic health diagnosis should contact Student Accessibility Services staff at 757-221-2512 or at sas@wm.edu to determine if accommodations are warranted and to obtain an official letter of accommodation. For more information, please see `https://www.wm.edu/sas`.

Honor Code: Students are expected to uphold the honor code in this class. Any suspected infraction will be reported. Rest assured, I am older and more experienced than you are. **I will catch you if you cheat!**

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Mental and Physical Well Being: William & Mary recognizes that students juggle different responsibilities and can face challenges that make learning difficult. There are many resources available at W&M to help students navigate physical/medical, emotional/psychological, material/accessibility concerns. Asking for help is a sign of courage and strength.
If you or someone you know is experiencing any of these challenges, we encourage you to reach out to the following offices:

- For psychological/emotional stress, please consider reaching out to the W&M Counseling Center (757-221-362), 240 Gooch Dr. 2nd floor, `https://www.wm.edu/offices/wellness/counselingcenter/`. Services are free and confidential.

- For physical/medical concerns please consider reaching out to the W&M Health Center at `https://www.wm.edu/offices/wellness/healthcenter/` or 757-221-4386, 240 Gooch Drive.

- If you or someone you know is in need of additional supports or resources, please contact the Dean of Students by submitting a care report (`https://www.wm.edu/offices/deanofstudents/services/caresupportservices/index.php`), by phone at 757-221-2510, or by email at deanofstudents@wm.edu.

As your professor, I also ask you to reach out to me if you are facing challenges inside or outside the classroom; I will guide you as best I can to appropriate resources on campus.