MTH 316: Algebra – Spring 2020 (Revised 3/20/20)

Department of Mathematics, University of Rhode Island

**Quick Details**

**Instructor:** Dr. Michael Barrus

**Office Location:** 101C Lippitt Hall

**Telephone:** (401) 874-4430

**Email:** barrus@uri.edu

**Office Hours:** By Zoom.us video conference (or jitsi.org, if necessary), 2-2:40 pm, MTWThF

**Class Days/Time:** No synchronous class meetings; videos will be posted on YouTube.com on Tuesdays and Thursdays by noon (Eastern) and linked to from Sakai.

**Prerequisites:** MTH 215 and 307

**Course Description**
Theory and structure of groups. Topics from ring theory, principal ideal domains, unique factorization domains, polynomial rings, field extensions, and Galois theory. –2019-2020 URI Undergraduate & Graduate Catalog

**Course Goals**
Students will gain familiarity with fundamental structures and results of group theory through experience with problem solving and investigation. They will be able to justify basic facts about groups using mathematical proof.

**Student Learning Outcomes**
A more specific topical list of learning outcomes will be created throughout
the semester and made available in Sakai. However, it is expected that upon successful completion of this course, each student will be able to do the following:

1. Define a group and give several different examples of groups; using the definition and fundamental results about groups, prove simple statements about groups.
2. Identify subgroups of a group and correctly use relevant terminology and notation.
3. Recognize and define cyclic groups; identify and count generators of cyclic groups and subgroups.
4. Define the permutation groups $S_n$ and $A_n$; use properties of permutations, such as order and parity, to answer questions about subgroups or elements.
5. Exhibit an isomorphism between two suitable groups or use invariant properties of groups to show that the groups are not isomorphic; use properties of isomorphisms and isomorphic groups to prove simple results; define and discuss the automorphism group and inner automorphism group of a group.
6. Compute the cosets of a subgroup of a given group; prove simple statements related to Lagrange’s Theorem; use ideas of orbits and stabilizers to describe the action of a permutation group on a set.
7. Compute the external direct product of two groups; apply basic results about how external direct products relate to cyclic groups and $U$-groups.
8. Determine whether a given subgroup of a group is normal; given a normal subgroup $H$ of a group $G$, compute the factor group $G/H$ and perform operations within this group; use theorems resulting from applications of factor groups to answer questions about group properties.
9. Determine whether a map between two groups is a group homomorphism; use the First Isomorphism Theorem and related results to answer questions about groups and homomorphisms.

**Required Text**


Cengage Learning, ISBN: 978-1305657960

**NOTE:** Life will be much more convenient for you if you have your own copy of Gallian’s text. Please make obtaining the use of one (whether through buying, renting, or long-term borrowing) an immediate priority; this is very important.

However, it is not necessary to have the most recent edition of the text. Earlier editions can be purchased much more cheaply, usually, than current editions (the downside is that newer editions can often be rented, while earlier editions must
usually be purchased). Earlier editions will likely have mostly the same structure and basic content as the updated edition. With a little help from me (eg., referring to section names, rather than page numbers, when discussing portions of the text, and providing you with typed lists of problems, rather than numbers of problems from the text), my hope is that you will be able to successfully and comfortably learn the course material using any edition of Gallian’s text.

How Class Will Be Conducted

Direct instruction will be accomplished through two primary means. First, students will read the textbook, following the schedule appearing on the last page of this document. The Learning Outcomes document, available in Sakai, will guide students in knowing what to focus on as they read.

Second, I will create and post a series of videos presenting course material and meant to supplement (but not replace) textbook content. These videos will be posted on YouTube and will be linked to in Sakai. Questions about video content can be posted as comments on the video or sent to me directly via email.

In addition to direct instruction, you will of course learn much (perhaps the most of all) through completing homework assignments (including Eli Review assignments) and preparing for quizzes and contacting me for help as needed. I will hold office hours online through video conference (through the website zoom.us, whenever possible, though if difficulties arise I may switch to jitsi.org or some other platform)—I will let you know via Sakai of any details you need in order to reach me, such as a meeting code. If you cannot attend a live office hours video conference, I encourage you to email me your questions ahead of time. If time permits, I will answer them during office hours and record the answers for linking to in Sakai.

In all online interactions, students are responsible for being familiar with and adhering to the published "Community Standards of Behavior: University Policies and Regulations" which can be accessed in the University Student Handbook. As with most university courses, all class participants are expected to behave in a respectful and safe manner at all times throughout the semester. Please do your best not to inhibit the learning experience of anyone else, and please feel free to bring any issues you have with others’ behavior to the attention of the instructor. Issues that may arise will be dealt with in as respectful and confidential a manner as possible.

Grading Policy

Grades will be determined through a weighted average with categories and weights as follows:

20%  Homework assignments (including Eli Review assignments)
Each grade category's components and policies will be described in sections that follow. No extra credit is anticipated for this course.

Letter grades for the course will be determined by considering your overall weighted percentage according to the scale on the next page:

<table>
<thead>
<tr>
<th>A course percentage of at least</th>
<th>A course guarantees a letter grade of at least</th>
</tr>
</thead>
<tbody>
<tr>
<td>93</td>
<td>A</td>
</tr>
<tr>
<td>90</td>
<td>A-</td>
</tr>
<tr>
<td>87</td>
<td>B+</td>
</tr>
<tr>
<td>83</td>
<td>B</td>
</tr>
<tr>
<td>80</td>
<td>B-</td>
</tr>
<tr>
<td>77</td>
<td>C+</td>
</tr>
<tr>
<td>73</td>
<td>C</td>
</tr>
<tr>
<td>70</td>
<td>C-</td>
</tr>
<tr>
<td>67</td>
<td>D+</td>
</tr>
<tr>
<td>60</td>
<td>D</td>
</tr>
</tbody>
</table>

A course percentage of less than 60% merits a grade of F.

**Homework Assignments**

**Written homework**

Written homework assignments will be announced in Sakai approximately once a week (typically due on Tuesday, though this may vary), for a total of roughly 10 assignments. Assignments may vary in content and format, depending on the current needs of the class, but both the details of the assignments and the deadlines will be announced in class and through Sakai.

Unless otherwise specified, for full credit each assignment must be received by the end of the day on which it is due. Homework must be submitted by uploading a scan or photos of the assignment using the homework submission tool in Sakai (or, in a pinch, by emailing me the file or files).

Solutions to all homework exercises must be clearly written with all necessary justification; a good write-up of your answer is just as important, usually, as a correct answer. Homework assignments will typically be graded as follows: most points will be awarded for one to three specific problems I will choose for grading in detail, and an additional number of points will be awarded based on completion of the rest of the problems.
I am happy to review your graded homework after it is graded. Any requests for regrading (on either homework or exams) must be brought to my attention within 2 weeks of the item's score's posting in Sakai.

**Eli Review homework**

This semester, in an effort to help you learn abstract algebra better, you will be assigned a writing prompt during most weeks to be completed using the peer feedback platform Eli Review (elireview.com). As will be explained in detail during the semester, you will create an account on the service (free for URI students) and submit brief writing assignments related to the course each week (typically due Monday night). During the next two days (by Wednesday night of most weeks) you will have the responsibility of reviewing and scoring/responding to the submissions of approximately 3 of your classmates (all submissions, and all feedback, will be anonymous). Completing your own submission and submitting feedback for your classmates will count as one homework assignment.

Admittedly, this is a new feature for MTH 316 (and math courses at URI in general). My hope is that the writing assignments, along with your opportunities to see what your peers submit and how I’d like you to assess them, will help solidify your understanding of these sometimes-very-abstract concepts. As we try these assignments out, your feedback to me on the Eli Review assignments will be always welcome.

**Late homework**

Please respect the homework deadlines as much as possible and expect that I will strictly enforce the policy stated here. Each assignment’s score will contribute roughly 1% of your overall course grade, and none of these scores will be dropped in calculating your course grade, so it is very important that you complete each assignment as correctly and as punctually as you can. Please note that *Eli Review* assignments cannot be completed late; in order for the peer feedback model to work, you will need to submit the writing assignments, and later your feedback for others, on time; no make-up for these assignments will be provided.

When *written* assignments must be turned in late, you are encouraged to turn them in **as soon as possible**. Late written homework may be accepted for 90% if turned in up to one class period after it is due, and up to 80% of its original value up until 10 University class days after it is due, after which the maximum that can be earned is 50%. (On occasion, I may be delayed in grading an assignment; when this happens, any assignments turned in before I begin grading will be counted as on time.) By University policy, **homework may not be accepted after April 28** (the last day of class for the semester).
**Group work**

Group work can be a wonderful thing, and I encourage it. However, do not simply copy someone else’s work verbatim or submit work that you do not understand; I consider this dishonest, and it is rarely beneficial to anyone’s learning. Please seek help early (from me, a classmate, etc.), and when you do receive help from someone besides yourself, be sure to clearly acknowledge that help with a statement on your homework.

Group work is not allowed for any exam.

**Groups Wiki Project**

Beginning with our discussion of Chapter 2, class members will work together to flesh out a Sakai wiki about a set of sample groups presented to the class. Each student will be assigned to make substantial contributions to the wiki entries of four groups (and notify the instructor while doing so) before each midterm or final exam to earn full credit for the assignment. More details on the assignment and its assessment will be provided as the semester progresses.

**Reading Report**

After the second midterm exam, each student will read one paper related to applications of group theory and write a report on it. A list of papers to choose from and a detailed rubric for the assignment will be provided in Sakai April 9, and the final reading report will be due April 24. (Late submissions will be penalized according to the same policies as late homework, including no credit for submissions after April 28.)

(Pre-Break) Weekly Quizzes and (Post-Break) Participation Checks

Thursdays of most weeks before Spring Break began with a short quiz and/or writing prompt over material discussed during the previous class period(s).

Following Spring Break, up to 10 points per week may be earned by completing a Google Form reporting that you have watched the YouTube video(s) released on Tuesday and Thursday and read the accompanying text; you will also be asked to pose a question related to the reading; more details will be provided on the Form.

It is hoped that the quizzes and participation checks will be an easy way to reinforce concepts and encourage you to keep up with the class (while giving us some early feedback if you need some clarification). Quiz questions can also be good indicators of what some questions may look like on an exam, and your responses on participation checks may inspire exam questions or the direction class takes in later weeks. Please see me soon if you have any questions in preparing for
the quizzes or participation checks, or if you are concerned about your performance on them.

**Missed quizzes and participation checks may not be made up,** except in cases of illness or other unavoidable absences, in which case alternative arrangements will be discussed on a case-by-case basis. The lowest four (4) quiz/participation check weekly scores will be dropped when computing your grade at the end of the semester.

**Midterm and Final Exams**

There will be two midterm exams, given on the following dates:

1. Tuesday, February 25;
2. Thursday-Friday, April 9-10.

The first exam will be held in our classroom during our usual class period. The second exam will be distributed as a PDF file in Sakai, and written answers should be submitted using as a Sakai submission (if this is not possible, they should be emailed to barrus@uri.edu).

Each will be worth 20% of your course grade. While the primary focus of the second midterm will be on the material covered after the first exam, you are expected to retain important information from the material tested by the first exam.

No notes, texts, calculators, or aids of any kind will be allowed on the first exam without written instructions from the instructor. For the second midterm exam and the final exam, the use of books, notes, and online resources are permitted as long as any resources used existed **before the exam was released;** it is dishonest to ask for help from any person or resource once the exam begins—once the exam is posted, all research and work on the exam must be your own. You will be required to identify resources you used on each exam and to sign a statement affirming that no unauthorized help was sought by or given to you.

The final exam will be comprehensive, though roughly half its content will focus on the material covered since the latter midterm exam. The final exam will be distributed via Sakai on **Thursday, April 30,** and will be due by 11 pm on **Monday, May 4.** University policies concerning the final exam will be strictly adhered to.

The best way to prepare for each exam will be to frequently test yourself on assigned homework exercises and the associated concepts, theorems, and learning outcomes (recorded in the learning outcomes document). More specific information will be given for each exam as it approaches.

**Accommodations for Special Needs**

Section 504 of the Rehabilitation act of 1973 and the Americans with Disabilities Act of 1990 require the University of Rhode Island to provide academic adjustments or the accommodations for students with documented disabilities. The
student with a disability shall be responsible for self-identification to the Disability Services for Students in the Office of Student Life, providing appropriate documentation of disability, requesting accommodation in a timely manner, and follow-through regarding accommodations requested. It is the student’s responsibility to make arrangements for any special needs and the instructor’s responsibility to accommodate them with the assistance of the Office of Disability Services for Students.

Any student with a documented disability is welcome to contact me as early in the semester as possible so that we may arrange reasonable accommodations. As part of this process, please be in touch with Disability Services for Students Office at 330 Memorial Union, 401-874-2098.

**Academic Honesty**

All submitted work must be your own. If you consult other sources (articles or books, including digital versions, resources belonging to other students from this or other universities/semesters, or online resources—including so-called “homework help” sites) these MUST be properly documented with a written comment on your assignment giving bibliographic information, or you will be charged with plagiarism/academic dishonesty and will receive a penalty for the assignment, up to and including a full loss of credit. In some cases, this may result in a failure of the course as well. In addition, the charge of academic dishonesty will go on your record in the Office of Student Life. If you have any doubt about what constitutes plagiarism, visit the URI Student Handbook and University Manual sections on Plagiarism and Cheating at [http://www.uri.edu/facsen/8.20-8.27.html](http://www.uri.edu/facsen/8.20-8.27.html).

For example, academic dishonesty includes (but is not limited to) the following actions:

- Using material, directly or paraphrasing, from published sources (print or electronic) without appropriate citation
- Claiming disproportionate credit for work not done independently
- Unauthorized possession or access to exams
- Unauthorized communication during exams
- Unauthorized use of another’s work or preparing work for another student
- Taking an exam for another student
- Altering or attempting to alter grades
- The use of notes or electronic devices to gain an unauthorized advantage during exams
• Fabricating or falsifying facts, data or references
• Facilitating or aiding another’s academic dishonesty
• Submitting the same paper for more than one course without prior approval from the instructors.

If you are unsure about whether an action you have taken or are considering is academically honest, please ask (sooner, rather than later).

Inappropriate Use of Course Materials
All course materials (e.g., outlines, handouts, syllabi, exams, quizzes, slideshows/presentations, lectures, audio and video recordings, etc., whether in tangible or digital form) are proprietary unless otherwise indicated by an explicit license presented with the material. In order to preserve the value of course materials and the educational experiences of later students, and to maintain appropriate copyright status for instructor creations, students are prohibited from posting online or selling any such course materials without express written permission from the instructor.

Religious Holidays
It is the policy of the University of Rhode Island to accord students, on an individual basis, the opportunity to observe their traditional religious holidays. Students desiring to observe a holiday of special importance must provide written notification to each instructor.
The following schedule is subject to change with fair notice to be given in class and through Sakai.

## Course Schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Topics, Readings, Important Dates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan. 23, 28, 30</td>
<td>Preface to group theory (including an introduction to $\mathbb{Z}_n$)</td>
</tr>
<tr>
<td></td>
<td><em>(Tues 1/28: Open add deadline)</em></td>
</tr>
<tr>
<td>Feb. 4, 6</td>
<td>Chapter 2: Groups</td>
</tr>
<tr>
<td>Feb. 11, 13</td>
<td>Chapter 3: Finite Groups; Subgroups</td>
</tr>
<tr>
<td></td>
<td><em>(Wed 2/12: Deadline to drop with no transcript entry)</em></td>
</tr>
<tr>
<td>Feb. 18</td>
<td>Comments on cyclic groups (including highlights of Chapter 4)</td>
</tr>
<tr>
<td>Feb. 20, 25</td>
<td>Review / catch up</td>
</tr>
<tr>
<td></td>
<td><strong>Tuesday, February 25: Exam 1</strong></td>
</tr>
<tr>
<td>Feb. 27, Mar. 3</td>
<td>Chapter 5: Permutation Groups</td>
</tr>
<tr>
<td></td>
<td><em>(Wed 3/6: Deadline to drop with transcript entry)</em></td>
</tr>
<tr>
<td>Mar. 5, 24, 26</td>
<td>Chapter 6: Isomorphisms, and an intro to homomorphisms</td>
</tr>
<tr>
<td></td>
<td><em>(Mon 3/9-Fri 3/20: Spring Break and class cancellation)</em></td>
</tr>
<tr>
<td>Mar. 31, Apr. 2</td>
<td>Chapter 7: Cosets and Lagrange’s Theorem</td>
</tr>
<tr>
<td>Apr. 7, 9</td>
<td>Review / catch up</td>
</tr>
<tr>
<td></td>
<td><strong>Thursday-Friday, April 9-10: Take-Home Exam 2</strong></td>
</tr>
<tr>
<td>Apr. 14, 16</td>
<td>Chapter 8: External Direct Products</td>
</tr>
<tr>
<td></td>
<td>Intro to Ch. 9: Normal Subgroups and Factor Groups</td>
</tr>
<tr>
<td>Apr. 21, 23</td>
<td>Chapter 9, continued</td>
</tr>
<tr>
<td></td>
<td>Highlights from Chapters 10 and 11: Group Homomorphisms and The Fundamental Theorem of Finite Abelian Groups</td>
</tr>
<tr>
<td>Apr. 28</td>
<td>Review of the course; final words</td>
</tr>
<tr>
<td>Finals Week</td>
<td><strong>Thurs - Mon, April 30 - May 4: Take-Home Final Exam</strong></td>
</tr>
</tbody>
</table>