Syllabus

Math 2230 – Introduction to Abstract Mathematics

Semester: Fall 2015
Time: 11:30-12:45, TR
Where: DSC 254 (Note the change of room)
Instructor: Dr. Dora Matache (call me Dora)
Office: DSC 228
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Web: http://www.unomaha.edu/doramatache/
Office Hours: 1:00-3:00pm TR or by appointment.

Text: K. Devlin, Sets, Functions, and Logic; An Introduction to Abstract Mathematics, third edition, Chapman & Hall/CRC, ISBN 1-58488-449-5
Additional course notes: Worksheets; adaptation of notes written by Dana Ernst, Northern Arizona University, http://danaernst.com/

Prerequisites: Math 1960 or permission. Credit will not be given for both Math 2030 (or Math 2040) and Math 2230.

Catalog description: This course provides a transition from the calculus to more abstract mathematics. Topics include logic, sets and functions, an introduction to mathematical proof, mathematical induction, relations. Important prerequisite material for a number of more advanced mathematics courses is studied.

Course description: The course trains students on methods and techniques of mathematical communication, focusing on proofs but also covering expository writing and problem-solving explanations.

Learning outcomes: Upon successful completion of the course, students will be able to:
1. Write a readable and mathematically rigorous proof.
2. Express in writing, knowledge of the terminology, concepts, basic properties and methodology of symbolic logic, set theory, functions, mathematical induction, cardinality, some elements of number theory, and relations.
3. Identify useful definitions and make correct deductions from definitions.
4. Identify correct proof structures and criticize incorrect proof structures (What about the watermark of this document?).

Purpose: The primary objective of this course is to develop skills necessary for effective proof writing. Students will improve their ability to read and write mathematics. Successful completion of MATH 2230 provides students with the background necessary for upper division mathematics courses. Also, the purpose of any mathematics course is to challenge and train the mind. Learning mathematics enhances critical thinking and problem solving skills.

$$a = b$$
$$a^2 = ab$$
$$a^2 - b^2 = ab - b^2$$
$$(a+b)(a-b) = b(a-b)$$
$$a + b = b$$
$$2b = b$$
$$2 = 1$$

 Parts of this syllabus are an adaptation of a syllabus written by Dana Ernst (Northern Arizona University).

Grading:

What	Weight	Notes
Homework	25%	Weekly homework
Presentations/Participation	25%	Each student must present **at least three times prior to each exam** (that's at least a total of 6 times during semester)
Midterm Exam, Thursday, October 15, 11:30AM (tentatively)	20%	In class + take home
Portfolio, Due the last week of school	10%	Each student must turn in the portfolio to get a grade on the final exam
Final Exam, Tuesday, December 15, 12:00PM	20%	In class + take home

Final grades will be assigned on the percentage of student's total score out of the total possible score. The normal ranges for grades based on these percentages will be:

Range	Grade	Range	Grade	Range	Grade
98-100%	A+	82-88%	B	70-72%	C-
92-98%	A	80-82%	B-	68-70%	D+
90-92%	A-	78-80%	C+	62-68%	D
88-90%	B+	72-78%	C	60-62%	D-

Grade F otherwise.

Learning management system: Blackboard https://blackboard.unomaha.edu/webapps/login/
It is the students' responsibility to check regularly for materials, announcements, updates etc.

Additional Course Notes - to be used as your main source of information: This is basically a task-sequence adopted for inquiry-based learning (IBL). The task-sequence that we are using was written by Dana Ernst (Northern Arizona University), and the first half of the notes are an adaptation of notes written by Stan Yoshinobu (Cal Poly) and Matthew Jones (California State University, Dominguez Hills).

In addition to working the problems in the notes, I expect you to be *reading* them and the textbook. It is your responsibility to read ahead to have an initial encounter with the concepts before you work on your own or with your peers on the tasks listed in the notes. The only way to achieve a sufficient understanding of the material is to be digesting the reading in a meaningful way. You should be seeking clarifications by asking questions in class, outside class, by email to everybody, or posting questions on Blackboard (blog tool, discussions etc.) so that everybody can contribute and learn more. I will not be the first one to answer a question. I expect the students to take charge.

Here's what Paul Halmos (http://en.wikipedia.org/wiki/Paul_Halmos) has to say about reading mathematics: *"Don't just read it; fight it! Ask your own questions, look for your own examples, discover your own proofs. Is the hypothesis necessary? Is the converse true? What happens in the classical special case? What about the degenerate cases? Where does the proof use the hypothesis?"*

Comments about this course and expectations: This course will likely be different than any other math class that you have taken before for two main reasons. First, you are used to being asked to do things like: “solve for *x*,” “take the derivative of this function,” “integrate this function,” etc. Accomplishing tasks like these usually amounts to mimicking examples that you have seen in class or in your textbook. The steps you take to “solve” problems like these are always justified by mathematical facts (theorems), but rarely are you paying explicit attention to when you are actually using these facts. Furthermore, justifying (i.e., proving) the mathematical facts you use may have been omitted by the instructor. And, even if the instructor did prove a given theorem, you may not have taken the time or have been able to digest the content of the proof.

Unlike previous courses, this course is all about “proof.” Mathematicians are in the business of proving theorems and this is exactly our endeavor. For the first time, you will be exposed to what “doing” mathematics is really all about. This will most likely be a shock to your system. Considering the number of math courses that you have taken before you arrived here, one would think that you have some idea what mathematics is all about. You must be prepared to modify your paradigm. The second reason why this course will be different for you is that the method by which the class will run and the expectations I have of you will be different. In a typical course, math or otherwise, you sit and listen to a lecture. (Hopefully) These lectures are polished and well-delivered. You may have often been lured into believing that the instructor has opened up your head and is pouring knowledge into it. I absolutely love lecturing and I do believe there is value in it, but I also believe that in reality most students do *not* learn by simply listening. You must be active in the learning you are doing. I’m sure each of you have said to yourselves, “Hmmm, I understood this concept when the professor was going over it, but now that I am alone, I am lost.” (I know that happened to me as a student and even later in life!)

Much of the course will be devoted to students proving theorems on the board and a significant portion of your grade will be determined by how much mathematics you produce. I use the word “produce” because I believe that the best way to learn mathematics is by doing mathematics. Someone cannot master a musical instrument or a martial art by simply watching, and in a similar fashion, you cannot master mathematics by simply watching; you must do mathematics!

Furthermore, it is important to understand that proving theorems is difficult and takes time. You shouldn’t expect to complete a single proof in 10 minutes. Sometimes, you might have to stare at the statement for an hour before even understanding how to get started. In fact, proving theorems can be a lot like the clip from the *Big Bang Theory* (https://www.youtube.com/watch?v=i5oc-70Fby4&feature=related).

In this course, *everyone* will be required to

- read and interact with textbook and course notes on your own;
- write up quality proofs to assigned problems;
- present proofs on the board to the rest of the class;
- participate in discussions centered around a student’s presented proof;

- call upon your own prodigious mental faculties to respond in flexible, thoughtful, and creative ways to problems that may seem unfamiliar on first glance.

As the semester progresses, it should become clear to you what the expectations are. This will be new to many of you and there may be some growing pains associated with it.

Goals: (Adopted from *Chapter Zero Instructor Resource Manual, by C. Schumacher*) Aside from the obvious goal of wanting you to learn how to write rigorous mathematical proofs, one of my principal ambitions is to make you independent of me. Nothing else that I teach you will be half so valuable or powerful as the ability to reach conclusions by reasoning logically from first principles and being able to justify those conclusions in clear, persuasive language (either oral or written). Furthermore, I want you to experience the unmistakable feeling that comes when one really understands something thoroughly. Much “classroom knowledge” is fairly superficial, and students often find it hard to judge their own level of understanding. For many of us, the only way we know whether we are “getting it” comes from the grade we make on an exam. I want you to become less reliant on such externals. When you can distinguish between really knowing something and merely knowing about something, you will be on your way to becoming an independent learner. Lastly, it is my sincere hope that all of us (myself included) will improve our oral and written communications skills.

A little more Propaganda: All of the secondary skills you will develop in this course are highly valued by society. Whether you become a teacher, a lawyer, an engineer, or an artist, what differentiates you from your competition is your ability to think critically at a high level, collaborate professionally, and communicate effectively. This is in line with UNO values as well: knowledge enriches the lives of all people and UNO is committed to preparing students to face the challenges of living and learning in an ever-changing world; UNO strives for an ideal educational partnership characterized by the commitment of students to learning.

Class Presentations: (Adopted from *Chapter Zero Instructor Resource Manual, by C. Schumacher*) Though the atmosphere in this class should be informal and friendly, what we do in the class is serious business. In particular, the presentations made by students are to be taken very seriously since they spearhead the work of the class. Here are some of my expectations:

- In order to make the presentations go smoothly, the presenter needs to have written out the proof in detail and gone over the major ideas and transitions, so that he or she can make clear the path of the proof to others.
- The purpose of class presentations is not to prove to me that the presenter has done the problem. It is to make the ideas of the proof clear to the other students.
- Presenters are to write in complete sentences, using proper English and mathematical grammar.
- Once the proof is on the board, presenters should turn to explain.
- Fellow students are allowed to ask questions at any point and it is the responsibility of the person making the presentation to answer those questions to the best of his or her ability.

- Since the presentation is directed at the students, the presenter should frequently make eye-contact with the students in order to address questions when they arise and also be able to see how well the other students are following the presentation.
- It is expected that all students will contribute throughout the semester with questions, comments, critiques, etc. We will not be moving on to the next presentation until there is some discussion at the end of the current presentation. All students should have at least one comment (question etc.) prepared to be expressed to the presenter.
- This may be out of your current comfort zone in the beginning, but it will become your new comfort zone later in the semester.

Presentations will be graded using the rubric below.

Grade	**Criteria**
25	The presentation contains all the important parts of a proof, it is well written, clarifies most or all details of the proof, and possibly contains only minor flaws. Yay!
15	The presentation misses some important parts, contains a significant gap, or minimal progress has been made that includes relevant information. However, it could lead to a proof or solution.
0	Oops!

Good news: You will be allowed to vote on your peers' presentations in order to determine their presentation grade. Of course, I will make the final decision on the presentation grade after averaging the student votes and mine.

You should not let the rubric deter you from presenting if you have an idea about a proof that you'd like to present, but you are worried that your proof is incomplete or you are not confident your proof is correct. You will be rewarded for being courageous and sharing your creative ideas! Yet, you should not come to the board to present unless you have spent time thinking about the problem and have something meaningful to contribute. As a matter of fact, certain mistakes can lead to very useful discussions! Of course, you should not choose wrong proofs on purpose, but don't be afraid of errors, or of being judged harshly if you don't have a perfect proof.

I will always ask for volunteers to present proofs, but when no volunteers come forward, I will call on someone to present their proof. Each student is expected to be engaged in this process. The problems chosen for presentation will come from the course notes. After a student has presented a proof that the class agrees is sufficient, I may call upon another student in the audience to come to the board to recap what happened in the proof and to emphasize the salient points.

In order to receive a **passing grade** on the presentation portion of your grade, **you must present at least three times prior to each exam** (1 midterm and 1 final) for a total of at least 6 times during semester. Your grade on your presentations, as well as your level of interaction during student presentations, will be worth 25% of your overall grade. I expect all students to have equivalent contributions to the evolution of the course.

Weekly Homework: You will be required to submit a number of formally written proofs each week (on Thursdays). They will be chosen from the problems indicated in the course notes, and they will be announced two days in advance (on Tuesdays, in class and posted on Blackboard). That means that you should work as much as possible before you come to class on Tuesday, so you can follow the presentations and have time to make any necessary corrections and finalize the homework nicely for Thursday.

Students are allowed (in fact, encouraged!) to modify their written proofs in light of presentations made in class. All assignments should be *carefully*, *clearly*, and *cleanly* written. Among other things, this means your work should include proper grammar, punctuation and spelling. You will almost always write a draft of a given solution before you write down the final argument, so do yourself a favor and get in the habit of differentiating your scratch work from your submitted assignment. Once a presentation is done and we move on I expect you to be able to write the proof in detail and in good format.

The Weekly Homework assignments are subject to the following rubric:

Grade	Criteria
25	This is correct and well-written mathematics; or This is a good piece of work, yet there are some mathematical errors or some writing errors that need addressing.
15	There is some good intuition here, but there is at least one serious flaw; or I don't understand this, but I see that you have worked on it. Maybe we can save this proof! Talk to your colleagues or to me for further discussions to save it.
0	I believe that you have not worked on this problem enough or you didn't submit any work.

Please understand that the purpose of the written assignments is to teach you to prove theorems. It is not expected that you started the class with this skill; hence, some low grades are to be expected. However, I expect that everyone will improve dramatically. Improvement over the course of the semester will be taken into consideration when assigning grades.

You can choose one Weekly Homework problem that received a score of 15 and resubmit within one week after the corresponding problem was returned to the class for grade improvement (basically with your next homework). The final grade on the problem will be the average of the original grade and the grade on the resubmission. Please label the assignment as “Resubmission” on top of any problem that you are resubmitting and keep separate from any other problems that you are turning in. Write your name.

You are allowed and encouraged to work together on homework. However, each student is expected to turn in his or her own work. In general, late homework will *not* be accepted. However, you are allowed to turn in 1 homework assignment late with no questions asked. Unless you have made arrangements *in advance* with me, homework turned in after class will be considered late. Your overall homework grade will be worth 25% of your final grade.

On each homework assignment, please write (i) your name, (ii) name of course, and (iii) Weekly Homework number.

Portfolio: Consist of the course notes with ALL proofs. This is separate from your homework, although the homework problems are chosen from among those in the course notes. You should structure the portfolio based on the separate worksheets, so that you have a complete account of what you have learned in this class. You can regard this as your own textbook that you can use later on in more advanced courses (such as Intro to Analysis). It should be *carefully*, *clearly*, and *cleanly* written. Among other things, this means your work should include proper grammar, punctuation and spelling. It is important to have it structured as neatly as possible, by separating the problems, clearly indicating the proofs. You can use a color guide to separate definitions from theorems or exercises. Use a notebook or nice paper for the portfolio. I will be checking your portfolios twice during the semester to make sure you are on the right track. This means that you should aim to finalize each worksheet or the portfolio as soon as possible after moving on to a new worksheet in class. Otherwise you may end up with a lot of work at the end of the semester. The first draft will be collected in early October.

Exams: There will be one midterm exam and a cumulative final exam. Each exam will be worth 20% of your overall grade and may consist of both an in-class portion and a take-home portion. The in-class portion of the midterm exams is *tentatively* scheduled for **Thursday, October 15,** and the in-class portion of the final exam will be on **Tuesday, December 15** at 12:00PM. Make-up exams will only be given under extreme circumstances, as judged by me. In general, it will be best to communicate (extreme) conflicts ahead of time. Examples of non-extreme circumstances: being locked out of the house; oversleeping; cat dying for the second time; headache; going on a hunting trip etc. You get the idea; all of these have solutions that need not interfere with showing up for exams. (Don’t laugh, I’ve heard versions of all these excuses over the years☺).

Rules of the Game: You should *not* look to resources outside the context of this course for help. That is, you should not be consulting the web, other texts, other faculty, or students outside of our course. On the other hand, you may use each other, the course notes, the textbook, me, and your own intuition.

Additional Information

Attendance: Regular attendance is expected and is vital to success in this course, but you will not explicitly be graded on attendance. Yet, repeated absences may impact your participation grade (see above).

Class Etiquette: Students are expected to treat each other with respect. Students are also expected to promote a healthy learning environment, as well as minimize distracting behaviors. In particular, you should be supportive of other students while they are making presentations. Moreover, every attempt should be made to arrive to class on time. If you must arrive late or leave early, please do not disrupt class.

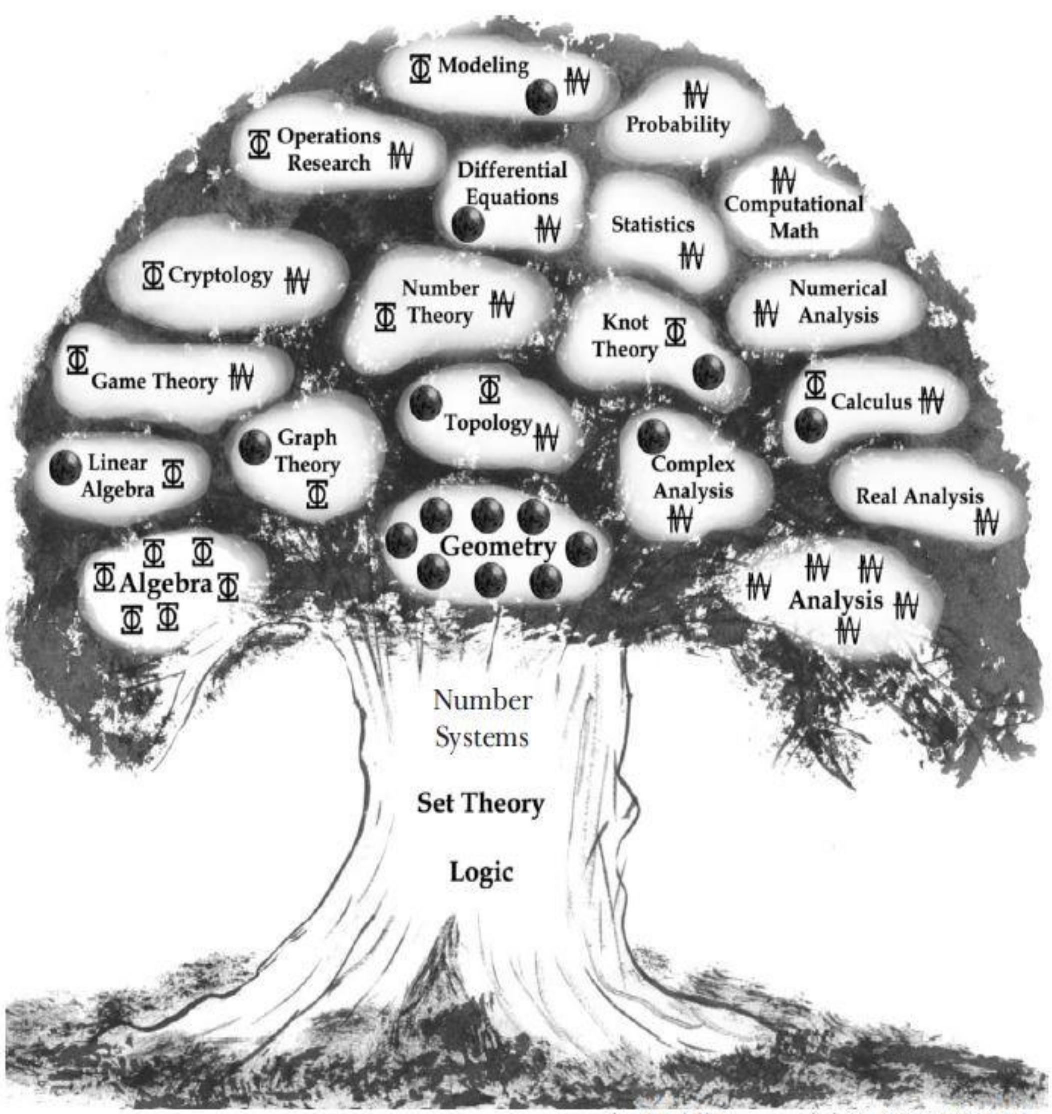
Please turn off the ringer on your cell phone. I do not have a strict policy on the use of laptops, tablets, and cell phones. You are expected to be paying attention and engaging in class discussions. If your cell phone, etc. is interfering with your ability (or that of another student) to do this, then put it away, or I will ask you to put it away.

Getting Help: There are resources available to get help. First, I recommend that you work on homework in groups as much as possible, and come see me whenever necessary, but after you have tried other sources of help. I will not give straight answers to your questions! I will only provide guiding questions or comments, so that you can discover the answer yourself.
It is your responsibility to be aware of how well you understand the material. Don't wait until it is too late if you need help. *Ask questions*! And ask them at the right time! Again, do not wait until it is too late, since I will not answer questions related to previous presentations. Lastly, you can always email me (dmatache@unomaha.edu), but make sure you send emails in a timely manner. Provide enough details and use clear, short, and targeted questions or comments. Include problem numbers. Example of a poor question: "I don't know how to start this problem, can you help me? Answer: NOT REALLY, you should be able to think of some meaningful related concepts or make a logical attempt." Here is a good question: "On this problem I performed the following and I reached this point in the proof where I am not sure what to use to continue. Could you give me a hint? Answer: YES….Hint follows…

Closing Remarks

(Adopted from pages 202-203 of *The Moore Method: A Pathway to Learner-Centered Instruction* by C.A Coppin, W.T. Mahavier, E.L. May, and G.E. Parker) There are two ways to approach this class. The first is to jump right in and start wrestling with the material. The second is to say, "I'll wait and see how this works and then see if I like it and put some problems on the board later in the semester after I catch on." The second approach isn't such a good idea. If you *try* every night to do the problems, then either you will get a problem (Shazaam!) and be able to put it on the board with pride or you will struggle with the problem, learn a lot in your struggle, and then watch someone else put it on the board. When this person puts it up you will be able to ask questions that help you and the others understand it, as you say to yourself, “Ahhh, now I see where I went wrong and now I can do this one and a few more for the next class.” If you do not try problems almost each night, then you will watch the student put the problem on the board, but perhaps will not quite catch all the details and then when you study for the exams or try the next problems you will have only a loose idea of how to tackle such problems. And then the anxiety will build and build and build. So, take a guess what I recommend that you do.

Final important word: Have fun! This is an awesome class if you do your part of the deal, despite the hard work and challenges. Your brain will grow this semester! Moreover, you will be prepared to take on higher level classes such as Intro to Analysis and the Analysis sequence, Probability and Statistics, Algebra, etc. Checkout the Tree of Math. Although not complete, it shows that this course represents the main trunk that supports everything else.



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