MATH 130: MATHEMATICAL FOUNDATIONS OF COMPUTING

SPRING 2022 **INSTRUCTOR: SUBHADIP CHOWDHURY**

Welcome to Math 130! You can call me Prof./Dr. Chowdhury. I am the instructor for this course, and I am glad to have you here!

WHAT IS THIS CLASS?

We will study **an area of Mathematics that computer science is built on**, called Discrete mathematics, and learn how to demonstrate proper understanding of discrete mathematics concepts and methods using proof techniques. Discrete math is the study of counting, patterns, and structures involving discrete (separate, not continuous) objects – like people, meals, clothing, and board games. We can use it to model and understand a wide range of real-world problems, from social networks to March Madness.

This class will be hard work. Part of doing real math is productive failure: You'll try things that don't work; learn something from that failure; and try something new that works a bit better. And… after a while, you will figure it out, and come out with a much stronger understanding of the structure of mathematics.

I WANT TO KNOW MORE ABOUT:

- Learning Goals
- Assignments and Grades
  - How do I earn a grade?
  - Details of Homework and Tokens
  - Details of Checkpoint Quizzes
- Policies
  - Attendance and Absences
  - Early and Late Work
  - Other Policies
- How to get help?
- Academic Integrity and Collaboration

KEY INFORMATION

Class meetings

MWF 9:00 – 9:50 AM, Taylor 200

Teaching Assistant

Khandokar Shakib (kshakib22@wooster.edu)

Office Hours

See Moodle for Up-to-date hours.
I will adjust these based on your feedback.

You can also stop by any time my door is open, or email me to set up an individual meeting.

How to contact me

Email: schowdhury@wooster.edu
Phone: 330-263-2473
Office: Taylor 307

Be sure to read my email responses policy.

Textbook

Al Doerr and Ken Levasseur, *Applied Discrete Structures*, ISBN: 978-1-105-55929-7.
The text is open-source and freely available online: http://faculty.uml.edu/klevasseur/ads2/

We will also use notes and activities written especially for this class.

Class materials and announcements

Available on: moodle-2122.wooster.edu/

Check Moodle and your Wooster email at least once before and after each class.

Additional college policies are listed in a separate document called Academic Policies, Procedures & Support Services.

This Syllabus repeats some of the same information in separate places. If something is not mentioned here, check Moodle first!

LEARNING GOALS

CATALOG DESCRIPTION

This course introduces discrete mathematics. Topics include set theory, logic, truth tables, proof techniques, sequences and summations, induction and recursion, combinatorial counting techniques, discrete probability, graphs, and trees.

Prerequisites: one CSCI course with minimum grade C-.

COURSE OBJECTIVES

Basically, this course teaches **mathematics applied to situations that involve things that can be separated and counted**. For example, counting the number of times a loop in a computer program executes involves separating things (the different iterations of the loop) and counting them. So, in Math 130, we look at the mathematical processes that computer science is built on, especially the structures that are the basis for the data structures you'll encounter later.

After successful completion of this course, you will be able to…

- Perform the operations associated with sets, functions, and relations
- Convert logical statements from informal language to propositional and predicate logic expressions
- Compute permutations and combinations of a set and interpret the meaning in the context of the particular application.
- Calculate probabilities of events and expectations of random variables for elementary problems such as games of chance.
- Apply formal logic proof techniques (direct proof, proof by contradiction, and induction, counting arguments) in the construction of a sound argument.
- Solve a variety of basic recurrence relations.
- Illustrate by example the basic terminology of graph theory, as well as some of the properties and special cases of each type of graph/tree.

MORE DETAILED OBJECTIVES

In addition to everything above, we will focus on some important ideas that span discrete mathematics as well as all of mathematics. Specifically, I want you to...

- **Succeed!** Specifically, I want you to develop a deep understanding of the ideas outlined above. You can expect me to push you in many ways to help you achieve these. As a result, this class will not be easy, but that's good: You learn by struggling!
- **Improve your ability to see patterns, make conjectures, and write proofs independently.** These will happen through class activities, homework, and quizzes. This will happen with time, experience, and hard work.
- **Apply the CCSS Standards for Mathematical Practice successfully in your mathematical work.** This includes perseverance in problem solving, reasoning abstractly, constructing arguments and critiquing others' arguments, modeling with mathematics, and looking for and making use of structure.
- **Learn math from a new point of view.** Discrete math is often surprising for students: It looks unlike most other kinds of math. That's great! Mathematics is truly about structure, pattern, and proof – things that will be central to our study of discrete mathematics.

WHAT ASSIGNMENTS WILL THERE BE?

More details are given in the rest of this document. Click each link below for details.

See "How do I earn a grade?" for an explanation of how these contribute to your final grade.

EXPLORATIONS AND READING QUIZZES (DAILY):

These form the basis for our daily class work.

Explorations are daily assignments to be completed before next class. These will introduce new ideas using things you already know and will help you make sense of new ideas. They will be graded for effort and completeness only. Make your best effort and bring your work to class, where you will be able to ask questions and discuss it together.

Class activities involve working individually, in groups, and through whole-class discussions. Your work will be brought together on these activity sheets.

HOMEWORK (EVERY 1 - 2 WEEKS):

Some computational, some proofs. Click the link for details.

CHECKPOINT QUIZZES (EVERY 2 WEEKS):

Rather than any midterm or final exams, we will have checkpoint quizzes periodically. You will have multiple opportunities to get fluency on the major objectives in our class, without penalty for needing multiple attempts. Click the link for details.

Generally, on a learning objective, we'll have the homework due first. Homework is both your chance to show me your best work (when you have a lot of time to work on it), and your chance to get feedback. Homework will tend to be longer, more difficult, and have more interesting problems that require some pondering or multiple attempts.

Then, after I get you feedback, there will be a quiz on the same objectives. The quiz will have fairly straightforward questions, and will *not* focus on polished communication, since it's timed. A quiz is your chance to prove that you can handle the fundamentals of each objective on your own.

How do I earn a grade?

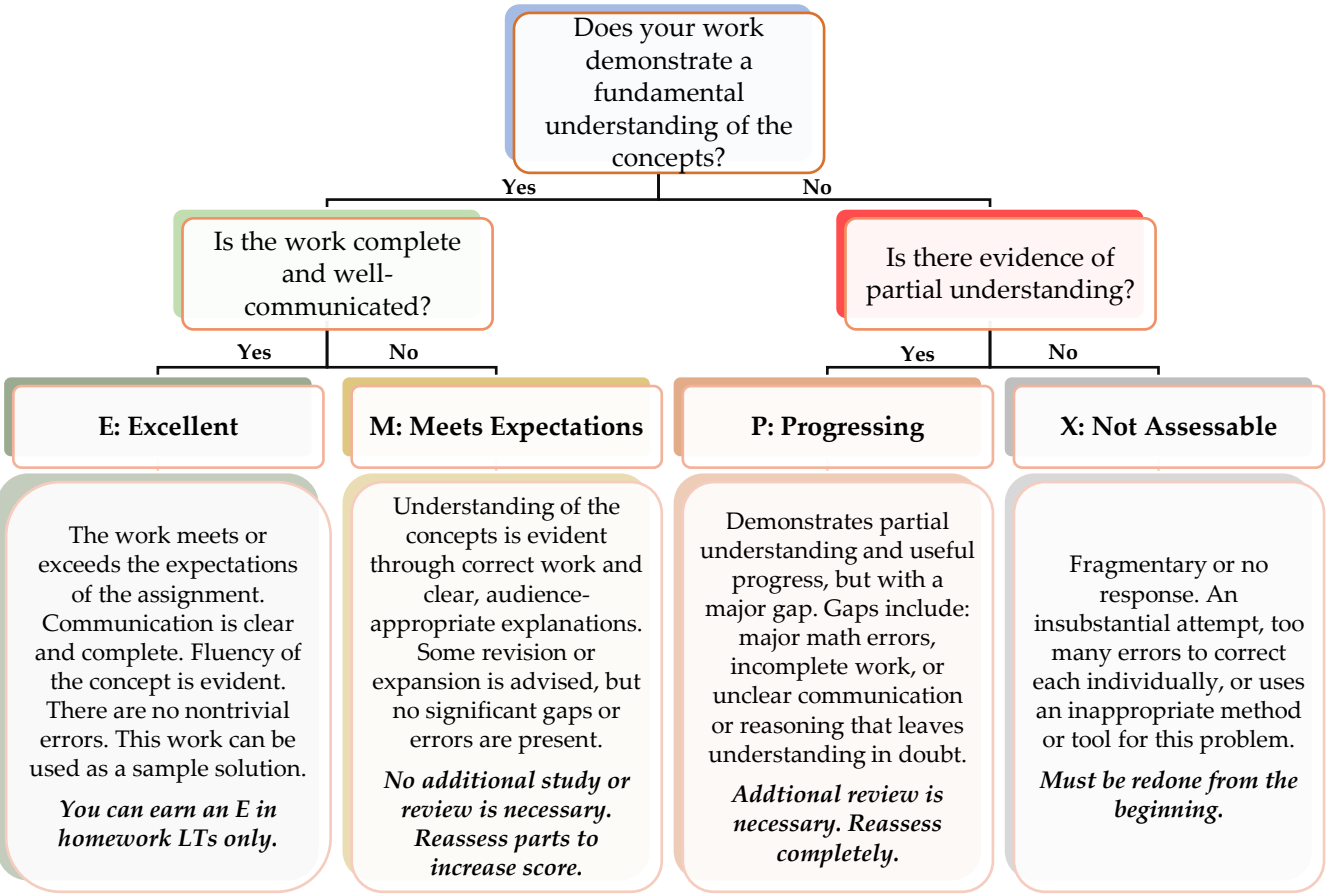
Our course is graded by a methodology called Learning-Based Grading system, also called standards-based or mastery-based grading, in which most graded work do not have a point value or percentage. Instead, you earn your grade by showing **appropriate engagement** with the course (by completing explorations and reading quizzes) and **demonstrating evidence of skill on the learning objectives** that describe the major ideas covered by each assignment. These objectives are listed in Appendix A and will be updated throughout the semester.

When you submit most work, I will evaluate it relative to quality standards made clear on each assignment. If your work meets the standard, then you will receive full credit for it. Otherwise, you will get helpful feedback and, on most items, the chance to reflect on the feedback, revise your work, and then reassess your understanding.

This feedback loop represents and supports the way that people learn. Learning happens over time, as we revisit ideas and reflect on them. In this class, your final grade will reflect how well you *eventually understand* each topic. You can make mistakes without penalty, as long as you *eventually* demonstrate fluency of the topic.

How are assignments scored?

In homework and quizzes, each Learning Targets (LT) will be assessed using one or more questions. For each LT, you'll earn a score in the EMPX scale. Here is what these letters mean:



Quick Fixes

You may sometimes earn a **P*** in a Quiz**.** This mark indicates work that contains an error which I think is minor, but I need to talk with you about it. **Come to my office to discuss a P* within 1 week after it is returned.** If you can convince me that the error was minor and explain how to fix it, then I will update the **P*** to an E or M for free -- it does *not* use up a reassessment attempt. After one week, a **P*** automatically becomes a **P** and must be reassessed as usual (and uses up your weekly attempt).

Learning Target Categories

Note that different versions of a particular LT will appear on both homework and quizzes. You must earn an E or M for **each objective on *both* a homework *and* a quiz** -- these are **separate** grade categories. Homework is intended to show your best possible work, while quizzes are intended to show your basic understanding of key ideas.

Note: One important thing to keep in mind during this class is that you should not be discouraged if you don't earn E or M on a LT the first time. That's normal. I'm only interested in what you can show me you can do by the end of the semester. However, *it's almost always better to reassess rather than waiting for a future opportunity to improve your mark*. That's because, while I will try to make sure many objectives appear a second time on a later quiz, I can't guarantee it will happen. You don't want to end up waiting until the end of the semester and then having to reassess 5 objectives, when there's only one week left.

How are Explorations and Reading Quizzes scored?

On most class days, you will receive a Moodle quiz (with one or two MCQs) on the topic you read about or learnt in class **due before the next class**. You will get infinitely many chances to get this right, and as such these exercises will help yourself assess your performance in class at any point. These are practice problems used to keep track of engagement, but are not scored otherwise.

How your final grade is determined

Your grade for the semester is not based on points because most items in the course don't carry point values. Instead, your grade will be based on the quantity and quality of evidence you can provide of across-the-board fluency of Math 130 - the basic skills found in the Learning Targets, and your daily work and engagement.

To determine your course **base grade** (the letter A/B/C/D/F without plus/minus modifications), use the following table. To earn a grade, you must complete all the requirements in the column for that grade; your base grade is the **highest grade level for which all the requirements have been met or exceeded.**

Category	D	C	B	A
Homework LTs (16)	E or M on 8 of the LTs	E or M on 12 of the LTs, and none with an X	E or M on all 16 LTs	E or M on all 16 LTs, at least 8 with an E
Checkpoint Quiz LTs (16)	M on 8 of the LTs	M on 10 of the LTs	M on 12 of the LTs, and none with an X	M on 14 of the LTs, and none with an X

If you do not meet all of the criteria for a D, your grade will be an F.

I will set +/- grades based on how close you are to the next higher (or lower) letter grade. For example, if you meet all criteria for an A except for one checkpoint LT, that may be an A-. If you are instead missing both a Homework and a Checkpoint LT, that may be a B+. I will communicate details of this on Moodle towards the end of the semester.

REASSESSMENTS

Checkpoints

Alternate checkpoint quizzes will be (partially) cumulative, so for example Checkpoint 2 might cover some new material plus material from Checkpoint 1, and so on. I will try to make sure that each Learning Target appears on at least two checkpoints. In this way, if your work on a problem in a Checkpoint doesn't meet the standard, you can just try it again at a later Checkpoint.

Retakes in Office Hours

You may attempt to improve your mark on **at most two different LTs every week.** There are two ways to do this:

- Make an appointment with me (preferably, but not necessarily, during office hours) to attempt one or two new problems that address that specific LT. You can reassess your marks on both a quiz and homework this way. The process is as follows:
    - Complete at least one set of problems on the LT from when it showed up in a checkpoint or homework. You can use the ZI, the TA, or my help for this part.
    - Bring your work to the meeting and I will give you new problems to attempt. These may be on paper or at the blackboard.
    - This can be any LT, no matter where we've assessed it. I may ask you to explain the meaning of the LT as well.
    - You will need to fill out a short cover sheet (available in Moodle) to finalize the process (and help me keep track of the reattempts).
- Revise problems from a quiz by re-doing any parts marked with **P*.** This does not take up a reassessment attempt. This must be done in-person at my office.

Note: A week for this course is defined as the period of time starting at 12:01am EST on Monday and ending at 11:59pm EST the following Sunday.

HOMEWORK

CONTENT

A homework set will typically have two parts:

Mathematical problems: These are traditional practice problems and proofs using the ideas we've learned in class. **They will be at a higher level of difficulty than quizzes.** See the LT list for details on what type of work is expected on homework.

Summary of recent work: Occasionally (every 2-3 weeks) I will ask you to summarize or review the topics that we have covered since the previous homework assignment. The goal here is to look back on what we've done, make connections to previous work, and to see the "big picture".

GRADES

Each problem will help you demonstrate proficiency of one homework LT. The corresponding LTs will be clearly stated on the assignment. You will earn an E, M, P, or X for each LT. To earn an E or M, you must show competency **on all of the relevant problems** in the homework. Summaries are graded for completion and effort. See "How do I earn a grade?" for a description of each mark. If you don't earn an E or M, you can earn it through a reassessment attempt (see Reassessments).

DUE DATE/TIME

All homework assignments are due at 5PM on the due date.

WRITING EXPECTATIONS:

These expectations will help demonstrate fluency (and, if done very well, earn an "E" mark), in addition to any other instructions given with the assignment:

- ***Explain fully and present a convincing argument.*** This is required for every problem, even if not explicitly stated. Use appropriate proof techniques, take care with quantifiers and logical reasoning, and communicate plans clearly to the reader.
- ***Follow the Math 130 Writing Guidelines (available in Moodle).*** This includes correct spelling, grammar, and punctuation amongst a whole bunch of other best practices.
- ***Turn in solutions for the questions in order*** (for example, do not turn in work for question 2 after work for question 1). The easiest way to do this is to ***start each problem on a new page*** and not put more than one answer on a single page.
- ***Make your answer legible.*** Your answer script should not look like scratch-work. Responses that consist of only answers with no work shown, or where the work is insufficient or difficult to read, or which have significant gaps or omissions (including parts left blank) will be given a grade of **X**.

COLLABORATION

See "Academic Integrity" for details.

POSTING SOLUTIONS:

For homework or exams, I will make the solution available to Moodle for only those students who have made a submission. This way, if you need an extension, you don't have to worry about the solution being public. Note that

because of the nature of grading, I may not always post solution and instead ask you to follow up with me in order to reassess a Learning Target.

TOKENS

Each student starts the semester with **4 tokens**, which can be used to *purchase* exceptions to the course rules. The token *menu* is below. To spend a token, send me an email. Everything listed here costs 1 token:

- Extend the deadline on a Homework by 24 hours. Deadline extensions must be requested prior to the original deadline.
- Reassess three different Learning Targets in the same week.

Please note that tokens may not be "*stacked*"; for example, you aren't allowed to spend 2 tokens and extend a deadline for 48 hours instead of 24 or assess four Learning Targets in the same week.

Tokens cannot be used to extend deadlines on Explorations or Checkpoint Quizzes.

I will update the number of remaining tokens per student as they are used.

CHECKPOINT QUIZZES

Rather than midterm exams, we will have an in-class checkpoint quiz roughly every other week. These quizzes will cover essential topics from previous classes. Topics will be announced several days in advance.

TIMING

There will be a quiz approximately every other week. Most weeks the quizzes will take all of class, with any remaining time used to discuss questions and homework problems.

CONTENT

Generally, quizzes will focus on computations and basic uses of each LT. See the LT list for details on what type of work is expected on quizzes.

GRADES

The goal of these quizzes is to ensure that you are fluent on the core ideas in class. Much like homework, one or more problems will help you demonstrate competency on one quiz LT. These targets will be clearly stated on the quiz and announced in advance. You will earn an M, P, or X for each target. To earn an M, you must show fluency on all the relevant problems in the quiz. See "How do I earn a grade?" for a description of each mark.

Note that an **E** is not available as a mark for quizzes since they are timed assessments and are not focused on polished communication.

If you don't demonstrate fluency of a topic, you can reattempt a related problem on a future quiz or during a scheduled reassessment attempt (see Reassessments for details).

COLLABORATION

Quizzes are individual assessments.

POLICIES

ATTENDANCE AND ABSENCES

Attendance is *crucial* to success in this class. Your best chance to discuss new material, ask questions, and avoid confusion is during class. So, don't miss class! You are responsible for all material and announcements from class, even in case of absence. Much of this information will be available on Moodle. Please check in with me and with your classmates when you are back.

That said, life happens. We get the flu. Relatives need your help. When this happens, do what you need to do. I trust that you are an adult and will make the best choices that you can. I appreciate it if you can notify me in advance of an absence, if possible.

If you think you will miss *more than one class in a row*, you should contact me beforehand to let me know, and meet me afterwards to discuss how you can catch up and move forward in the course. If you miss *an entire week*, I will send out an academic alert. If you miss *more than two weeks* of classes, you should contact the Dean Jen Bowen and/or Amber Larson, Director of the Academic Resource Center. They can help you consider options for completing or dropping the course.

According to college policies, a student *may not miss more than 25% of class meetings*, through any combination of excused and unexcused absences. If this occurs, I will notify you. If there are documented extenuating circumstances, you may petition for a late course withdrawal.

EARLY AND LATE WORK

Early Work

Explorations and homework: If you know about an absence in advance (including any religious holiday), you may arrange an early drop-off time for exploration assignments and homework, send work with a friend, or leave it with our TA.

Quizzes: You can arrange to take a quiz early if you contact me **at least 2 days in advance**. See me with special cases.

Make-up Work

The daily Explorations and Reading Quizzes are essential in order to be ready for class, so they may *not* be handed in late.

Homework can be turned in 24 hours late using a token.

Checkpoint Quizzes may *not* be taken late, but since they are based on getting fluency on objectives, you may have an opportunity to assess the same objectives on a later quiz with no penalty. If you have *significant* extenuating circumstances that cause you to miss multiple assignments (even with tokens), see me to discuss arrangements.

OTHER POLICIES

Special Accommodations

The Academic Resource Center, which is in APEX (Gault library) offers a variety of academic support services such as time management and class preparation, ELL peer tutoring, coordinating accommodations for students with diagnosed disabilities, etc. Please see the Academic Policies, Procedures & Support Services document for further details or go to the ARC website.

Email Responses

I do my best to reply to emails promptly and helpfully. However, I receive a lot of email. To help both you and me, here are some specific expectations about emails:

- If you email me between 8:00 am and 6:00 pm on a *weekday*, I'll reply to you on the *same* day.
- If you email me in the evening or overnight (after 6:00 pm), I will reply to you the *next weekday*.
- **If your email asks a question that is answered in the Syllabus or on Moodle** (such as in an announcement or an assignment sheet), I may reply by directing you to read the appropriate document.
    - If you've read the relevant document and still have questions about it, please make this clear in your email, by describing what you've already read, and which specific part of it you have a question about.
- Often, it's much easier to discuss questions in person. I may ask you to meet with me in my office (at a time that works for both of us) rather than answering directly in an email.
- On homework or exploration questions, please include photos, PDFs, or links if possible.

How to get help

My Office Hours

Please come see me during my office hours if you have questions or just want to discuss something from class. These will be most effective if you have spent some time formulating your questions beforehand - often you will answer your own questions during that process! You can also contact me via Email or MS Teams with your questions. See the email response section above for my 'business hours'!

See Moodle for office hour times and further instructions.

Teaching Assistant Office Hours

Khandokar Shakib (class of '22) is your TA for this course. He will be present during most classes to help me run group activities, answer your questions, and will hold office hours outside the classroom. In most cases, he will be the next immediate point of contact after myself if you need help with any coursework.

See Moodle for his office hour times and further announcement from him.

STEM Zone Intern

Quan Nguyen Hien (class of '22) is your ZI for this course. He will assist with problem sessions, going over **older quizzes and past assignments** much in the same way as me: by answering questions and providing guidance. The main role of a zone intern is to be a peer-tutor and mentor to help strengthen your understanding of the course material. Your zone intern will hold their own office hours within the math center.

Your ZI's office hours in the Math Center will be posted on Moodle.

ACADEMIC INTEGRITY AND COLLABORATION

In this class, your primary goal in this course is to develop a deep *personal* understanding and expertise in the Mathematical tools used in Computer Science. Collaboration and cooperation are extremely helpful in the learning process, and we will have many opportunities for collaborative work. However, there are some portions of our class that must be done independently.

The College's understanding and expectations regarding issues of academic honesty are fully articulated in the Code of Academic Integrity as published in The Scot's Key and form an essential part of the implicit contract between the student and the College. The Code provides framework at Wooster to help students develop and exhibit honesty in their academic work. You are expected to know and abide by these rules.

In this class, we will use the following definition of plagiarism:

> **Plagiarism** is the act of submitting the work of someone else as if it were your own. Specifically, this action misleads the instructor to think that the work is the result of learning and understanding by the student named on the paper, when in fact the understanding truly belongs to someone else. This may apply to an entire solution, or individual parts of a solution.

In Math 130, collaboration is permitted and even encouraged in some circumstances! However, **you may only collaborate with students currently enrolled in Math 130.** In all cases where collaboration has occurred, you must acknowledge this clearly:

> **Acknowledging collaboration:** In *all* work, you must clearly state the name(s) of the person(s) you collaborated with on each problem.

Specific academic honesty expectations:

It is often unclear what exactly "collaboration" means when working on homework. The following section should clarify what my expectations are regarding this and give guidelines for avoiding plagiarism in assignments. The list is intended to be helpful but not exhaustive. If you are unsure about the appropriateness of some form of assistance on an assignment, you should always ask me.

- ***Homework problems:*** On every homework problem, every step of every solution must be one that you understand yourself and that you have generated on your own. You are permitted to discuss big ideas and hints with your classmates. However, **you must work independently when writing up solutions.**

  > *All collaboration on homework exercises should occur when your collaborator is at essentially the same stage of the problem solution as yourself. In particular, if you have not yet started problem #4 and you ask a friend (who has already completed it), "How did you do problem 4?",* **this counts as plagiarism**. *The resulting work is not and* **cannot** *be considered your own.*

- ***Daily Exploration and Reading Quizzes:*** Working independently on these helps to ensure that you can solve key problems yourself later in checkpoint quizzes. In these exercises, the only help allowed is consultation with me.

- ***Outside resources in general:*** On all work, unless directly stated otherwise, the only resources you may use are our class notes (including explorations and activity worksheets) and the approved textbook (see the first page). You are not permitted to go looking for completed solutions to problems in other texts or resources. *In particular, use of internet resources is completely off limits for homework problems*. Often, full solutions for our

homework problems can be found online. If you see such a solution prior to submitting homework, there is essentially no way that you can claim to have an original solution. Evidence of using internet sources in your work will result in a **minimum** penalty of earning an X on the relevant objectives.

- ***Copying:*** Copying a solution, or any part of a solution, from any source (friend, internet, book, etc.) in any setting, constitutes plagiarism.

- ***Past students:*** On any assignment, basing your work on the efforts of another student who previously completed this course, or one like it (e.g., Math 215, Math 223, etc.), is considered plagiarism.

- ***Other instructors, the Math Center (ZIs), and TA:*** You are *not allowed* to discuss any Homework or Checkpoint Quiz problem with the ZIs, our TA, or seek the help of an instructor or tutor (other than me) *before the assignment is due.* You are *encouraged to seek their help after you have submitted an assignment* and need help checking or understanding a concept. If you seek their help before submission, this will be considered plagiarism. I am always willing to discuss any aspect of the course with you.

Consequences of academic dishonesty

Evidence of dishonest behavior on any assignment will be grounds for a minimum penalty of earning an X on all relevant objectives for that assignment. Other penalties may include permanently failing the relevant objectives (regardless of other work) or, in severe cases, failure of the course. Peers who willingly assist others in acts of plagiarism are equally guilty and will suffer similar penalties. In all cases, the guidelines established in The Scot's Key will be followed. I reserve the right to discuss the nature and origins of any assignment with any student prior to assigning a grade.

A POSITIVE NOTE

Remember that I want you to be successful. That is, I want you to develop a deep, personal understanding of the material we study so that you become a better student of mathematics who can go on to do well in all of your future endeavors. Every part of this course structure – including both collaborative work *and* restrictions on collaboration – are intended to help you with this. You will often struggle, and that's intentional – struggle (and eventual success!) is essential to learning. Indeed, productively failing (and learning from it) is part of your final grade.

In all aspects of the course, please understand that I am generous with hints and am always willing to discuss problems with you. I will never simply give you an answer, but I will offer direction and guidance that will assist you in coming up with a solution on your own. This is by far the most satisfying way to solve a problem, and the difficulty is well worth it. You are always welcome to discuss your questions or concerns with me at *any* time.

APPENDIX A: MATH 130 LEARNING TARGETS

These objectives will appear on homework and quizzes throughout the semester. Your goal is to earn an "M" or "E" on each objective, **both** on a homework and a quiz. Some objectives will only be available on homework.

QUIZ: LTs on quizzes are more direct and computational.
HOMEWORK: LTs on homework require clear and complete communication of your work and may require critiquing others' use of the principles.

CA. COMPUTER ARITHMETIC (1)

CA1 (Binary Representation of Positive Integers)

❖ **CA1Q:**
Convert between binary and decimal representation of positive integers. Perform addition in binary.

ST: SET THEORY (3)

ST1 (Set Notation and Relations)

❖ **ST1Q:**
Represent a set using roster notation and set-builder notation. Determine if an object is an element of a set, and determine set relationships (equality, subsets).

ST2 (Set operations)

❖ **ST2Q:**
Perform operations on sets (intersection, union, complement, Cartesian product), determine the cardinality of a set, and write the power set of a finite set.
❖ **ST2HW:**
Everything from quizzes, plus: Find examples of sets with given properties.

CP: COMBINATORICS AND PROBABILITY (6)

CP1 (Basic Rules)

❖ **CP1Q:**
Use the multiplication principle, the sum principle, and the Inclusion-Exclusion principles appropriately within a counting problem, including choosing process/sets in an appropriate order, applying cases as necessary, and using complements.
❖ **CP1HW:**
Everything from Quizzes, plus use the principles to calculate the cardinalities of various sets, including unions, complements, and others, for 2 or 3 sets. Communicate your work clearly and completely, including defining and identifying all process/sets.

CP2 (Permutations)

❖ **CP2Q:**
Use permutations and r-permutations appropriately within a counting problem. Use factorials and the shortcut formula as necessary. Avoid over- or under-counting.
❖ **CP2HW:**
Everything from quizzes, plus: Identify why order matters in a problem and be able to justify the shortcut formula.

CP3(Combinations)

❖ **CP3Q:**

Use combinations appropriately within a counting problem. Use the binomial symbol correctly and write out the shortcut formula as necessary. Avoid over- or under-counting.

❖ **CP3HW:**

Everything from quizzes, plus: Identify why order does not matter in a problem, be able to justify the shortcut formula, and find multiple ways to solve a problem using combinations.

LP: Logic and Proof Techniques (7)

LP1 (Propositional Logic)

❖ **LP1Q:**

Identify the parts of a conditional statement and write the negation, converse, and contrapositive of a conditional statement.

❖ **LP1HW:**

Everything from quizzes, plus: Write the negation of compound statements involving logical operators.

LP2 (Equivalence, Implications, and Laws of logic)

❖ **LP2HW:**

Construct truth tables for propositions involving two or three variables and use truth tables to determine if two propositions are logically equivalent.

LP3 (Quantifiers)

❖ **LP3Q:**

Determine whether a quantified predicate is true or false, and state the negation of a quantified statement.

❖ **LP3HW:**

Everything from quizzes, plus: write a proof of a statement involving quantifiers.

LP3 (Proof Techniques)

❖ **LP4Q:**

Outline the proof structure of a given statement using a proof technique. Identify logical errors in a proof.

❖ **LP4HW:**

Everything from quizzes, plus: Create a precise conjecture statement based on data. Write a correct, complete, and clear proof by contradiction and a proof by contrapositive.

MA: Matrix Algebra (3)

MA1 (Definition and Operation)

❖ **MA1Q:**

Define the order of a matrix and perform Matric addition and multiplication of 2 by 2 matrices.

❖ **MA1HW:**

Everything from quizzes, plus: Perform matrix operations on 3 by 3 matrices.

MA2 (Inverse and Determinant)

❖ **MA2HW:**

Define and evaluate the inverse and determinant of a matrix.

RF: Relations and Functions (4)

RF1 (Graphs, Matrices, and Properties of Relations)

❖ **RF1Q:**

Draw the digraph of a relation.

❖ **RF1HW:**

Everything from quizzes, plus: Determine whether a given relation is symmetric, reflexive, and transitive.

RF2 (Domain and Range of Functions)

❖ **RF2Q:**

Determine whether a given relation is a function; determine the domain, range, and codomain of a function; and find the image and preimage of a point using a function.

❖ **RF2HW:**

Everything from quizzes, plus: Determine whether a given function is an injection, surjection, or bijection.

RI: Recursion and Induction (6)

RI1 (closed-form and recursive expressions for sequences)

❖ **RI1Q:**

Generate several values in a sequence defined using a closed-form expression or using recursion. Find a closed-form and recursive expressions for arithmetic and geometric sequences.

❖ **RI1HW:**

Everything from quizzes, plus: Create a recurrence for a given situation, including initial terms, and check whether a proposed solution to a recurrence relation is valid. Critique a given explanation for a recurrence relation.

RI2 (Solving Recurrence Relations)

❖ **RI2Q:**

Solve a second-order linear homogeneous recurrence relation using the characteristic root method.

❖ **RI2HW:**

Everything from quizzes, plus: Analyze whether an explicit solution is an improvement over iteration for the complexity of algorithms.

RI3 (Mathematical Induction)

❖ **RI3Q:**

Given a statement to be proven by mathematical induction, State and prove the base case, state the inductive hypothesis, and outline the proof.

❖ **RI3HW:**

Everything from quizzes, plus: other forms of proof by induction.

GT: Graphs and Connectivity (2)

GT1 (Terminology)

❖ **GT1Q:**

Use and work with basic terms such as “graph”, “vertex”, “edge”, “degree”, etc. correctly in the context of graph theory problems. Use graph notation correctly (such as writing the names of edges, using sets of vertices or edges, using degrees, etc.). Find an example of Eulerian circuit or path in a graph or explain why they can’t be found.

❖ **GT1HW:**

Everything from quizzes, plus: Determine if a degree sequence is graphic and if two given graphs are isomorphic.

Appendix B: Tentative Course Schedule

Week	Monday	Wednesday	Friday
1 (Jan 17 - 21)	MLK Day	First Day of Class (Syllabus Discussion)	Binary numbers
2 (Jan 24 - 28)	Set notation, relations, and operations	Sets, Sums and Products	Checkpoint Quiz 0
3 (Jan 31 - Feb 4)	Counting: product rule and permutations **+ HW 1**	PIE and Combinations	Probability
4 (Feb 7 - 11)	Practice Problems **+ HW 2**	Logic: propositions and truth tables	Checkpoint Quiz 1
5 (Feb 14 - 18)	Equivalence, implication **+ HW 3**	Laws of logic	Quantifiers
6 (Feb 21 - 25)	Quantifiers ctd. **+ HW 4**	Proof Techniques	Checkpoint Quiz 2
7 (Feb 28 - Mar 4)	Basic definitions and operations on matrices **+ HW 5**	Identity matrix, Inverse and Determinant	Relations
8 (Mar 7 - 11)	Properties of Relations **+ HW 6**	Functions	Checkpoint Quiz 3
11 (Mar 28 - Apr 1)	Properties of Functions **+ HW 7**	Sequences, Arithmetic and Geometric	Recursion and recurrence relations
12 (Apr 4 - Apr 8)	Solving Recurrence Relations **+ HW 8**	Solving Recurrence Relations contd. + **Challenge 3**	Checkpoint Quiz 4
13 (Apr 11 - Apr 15)	Analysis of Complexity **+ HW 9**	Proof by Induction	Practice Problems
14 (Apr 18-22)	Graph terminology and isomorphism **+ HW 10**	Representing graphs	Checkpoint Quiz 5
15 (Apr 25 - 29)	Walks **+ HW 11**	Connectivity	No Class (IS Symposium)
16 (May 2 - 6)	Eulerian and Hamiltonian Walks **+ HW 12**	Review	Checkpoint Quiz 6

Frequently Asked Questions

When you read the syllabus, right click at any point in the document to add a comment and ask a question. I will compile these questions and add them in this section.

Checkpoint Quizzes

❖ *Why is there a checkpoint 0?*

I like patterns. HW (2n-1) and HW (2n) covers the material of Checkpoint (n). Checkpoint 0 will be a short quiz on the first two learning targets and will also give you an idea of what future checkpoints will look like.

Grading

❖ *Wait so there is no partial credit??!!*

Correct, because there is no "credit" to begin with. It's binary: Your work either meets the requirements for an M or E or it does not.

This might be terrifying to those who got through school by gaming the system, leveraging partial credit to use competence in one topic to paper over incompetence in another. But at the college or university level, this is not only unethical but also dangerous. Would you like your heart surgeon or the engineer who built the plane you're riding on to have gotten their degrees this way?

Here in Math 130, we insist on real competence, consistently and across the board. You can't make up for a lack of growth in one key area by growing twice as much in another.

Again, possibly terrifying. But never fear, this is what the revision/reattempt process is for. Work is never one-and-done; if you don't meet the standard, you'll be told explicitly what to work on and given plenty of chances to try again. The motto is high standards, with high support.