Welcome to Math 330 Discrete Math – Fall 2018

11:00 - 11:50 M-F in SAMU 108

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The best ways to contact me are email, Canvas message, and office hours. If there's something I need to remember for later PLEASE put it in email or Canvas message! If I don't reply within 24 hours over a business day, please contact me again. While I strive to be responsive and prompt, sometimes things get put off for later and unintentionally forgotten.

Text: *Mathematics for Computer Science*, by Eric Lehman, F. Thomson Leighton, Albert R. Meyer, available freely on the web at https://courses.csail.mit.edu/6.042/spring18/mcs.pdf as well as on Canvas. You may notice that one of the authors of this book, F. Thomson Leighton, is CEO Akamai Technologies, and Eric Lehman is a software engineer at Google – they are doing their best to present ideas that will be of use to you later. I have enjoyed reading this book; it has a lot of subtle humor woven into the technical information. That said, you may need to use resources such as Khan Academy online in addition to the textbook to learn the material.

This syllabus is subject to modification. Students will be notified of changes in class and on Canvas.

Course Goals: Math 330 is a course in the mathematics behind computer science concepts and applications. Mastery of college algebra is required for success in this course. This course is meant to familiarize you with mathematics foundational to computer science such as the logic rules you learned in Math 260, and math that is used to analyze algorithms, such as recurrence relations and counting arguments, and math in computer science applications, such as applications of graph theory. Understanding why things work, and being able to explain your logic is as or more important than getting the correct answer. Abstract thinking, logic and (un)common sense are required for success.

A complete list of learning objectives for the course is provided at the end of this syllabus.

Grades/Exams/Homework

Grades: We will be using Standards Based Grading this quarter in Discrete Math, which means that the course is broken down into areas of relates learning objectives, called standards, and students must demonstrate their competency on the standards to get a C, B or A for the course. Students may retest on the standards if their first attempt was not successful.

At the end of the syllabus, you will find the learning objectives for the course separated into 19 standards (this is also on Canvas). Eight of the 19 standards are required areas; to indicate this, they are marked with an R at the end of the name. Example: C1R is required, and C3 is not. Tests on standards will be graded with an A (4, excellent) or B (3, very good) or Not Yet (NY, 1) passed.

To get a C in the course, a student must pass 9 standards, including all 8 required standards, and obtain a 70% or better score on homework and reading assignments.

To get a B in the course, a student must pass 12 standards, including all 8 required standards, with at least 8 evaluated as an A, and obtain a 75% or better score on homework and reading assignments.

To get an A in the course, a student must pass 15 standards, including all 8 required standards, with at least 11 evaluated as an A. Additionally, students must obtain an 85% or better score on homework and reading assignments.

Other grades will be assigned based on this standard as logically as possible.

Standards Based Grading and Standards Testing: Testing on required standards will occur in class as we finish up a unit. On challenging material, students should expect to retest during office hours or by appointment. If you are planning to retest in office hours, please let me know a day ahead of time so I can try to have the evaluation prepared for you. The **last** opportunity to test in office hours is Wednesday of the last week of the quarter and, after that, the very last opportunity to take tests is during the final exam period for our class.

- You are expected to be ready for a test when it is first given in class. On one standard, you may decline to take a test with the class (or have one unexcused absence on a test day) and still be eligible for an A on that one standard. Otherwise, if you decline to take a test, or have an unexcused absence that day, the highest grade you can earn on that standard will be a B. You must come in to take the test on the standard within 2 class days of missing it.
- You may test on a required standard 5 times.
- You may test on an optional standard (that is not done as a take-home test) up to 3 times.
- If you have not passed a standard and must or you wish to pass it, you must retest on a standard at least once a week from the time it is offered until it is passed. If you do not retest for over a week, I will consider your effort to pass it abandoned.
- You may retest on a standard at most once a day or at most two times a week.
- Let me know a day ahead of time with the name of the evaluation you want to take to test or retest on during office hours or by appointment.
- **In order to take a test or retest, you must have been to the class meeting prior to the office hour or provide evidence of an excused absence.**
- In order to take a 3rd or a 5th test, students must redo and resubmit homework over that standard.
- If you are not successful in a retest on a standard, I recommend you take time to meet with me to go over the questions you missed so that you are better prepared to retest. **I recommend you retest as soon as possible, and continue retesting until you are successful.**
- Tests are not returned to students, although I am always happy to go over these with you in office hours.
- You may not retest the same day as you go over solutions to an old test.
- You must maintain a 70% or better on homework and reading assignments to pass the class with a C.

Homework and Reading: The practice problems I assign are mean to help you to learn the material you will be tested on. I expect your homework to be neat, complete, correct and well-explained **by the day the homework is due.** Assignments will be graded accordingly.

Reading assignments are to familiarize you not only with material you will be tested on, but also to give you a broader perspective on the interplay between mathematics and computer science. Reading assignments consist of reading a section or several sections of material usually from the textbook and providing a summary of what you read while answering a few questions on Canvas.

Attendance: I take attendance daily. For every 8 class days missed, a student will be required to pass an additional standard in order to achieve a given grade.

A student is tardy if they arrive after class has begun; students who are more than a few minutes late may be marked absent for the day. A student who leaves during the middle of class or who leaves class early may be marked tardy or absent. A tardy is counted as 25% of an absence.

Excused absences generally come with some kind of formal documentation. When possible, they should be arranged ahead of time, examples include a university field trip, a court date, or a doctor's appointment. For sudden and unexpected emergency, contact me as soon as possible. Notification and documentation (if available) must be provided within 2 working days of the absence. These will be handled on a case-by-case basis, and are generally counted as half of an unexcused absence.

One serious consequence of missing class is that you will not be allowed to take any evaluations in the next office hour after the missed class. Exceptions may be made for documented excused absences.

Office Hours and Getting Help: Office hours are scheduled to make sure there is a time that you can come see me because you have questions on course material or have issues that you otherwise want to talk to me about. I welcome your visit. Keep in mind, it is impossible for me to schedule office hours at a time convenient to everyone, and I encourage you to ask for an appointment if you need one. I also strive to promptly answer questions posted over email or by Canvas message. I usually reply within 1 business day. If I don't reply to your message within 2 business days, please assume something happened to your message and contact me again.

If you can't attend office hours, you are welcome to ask questions by email or by Canvas message. If you want an appointment, please send me an email and suggest several times when you are available so we can find a mutually convenient time to meet.

Academic Integrity: All in-class tests and evaluations taken during office hours are expected to be done without any resources except those explicitly authorized by the instructor. Do not discuss tests with others who may not yet have taken the test yet, or within earshot of someone who may be taking it at a later time. Any work done at home may be discussed with others, but what you hand in should represent your own understanding of the material, and should not be copied from others.

If a paper or report is assigned, students are expected to conform to academic standards for citing summarized, paraphrased and quoted work used; if you are not sure what this means, please **ask**.

Cheating will result in a zero on the assignment, quiz or exam. Cheating will be reported to the office of student conduct. Egregious offenses may result in a failing grade for the course and/or more serious consequences.

Late and Make-up Policy: Field trips, illnesses, accidents and deaths in the family are a part of life. I will arrange to take late work or for a make-up or alternative if you contact me either ahead of time or within 24 hours and provide documentation.

I expect you to hold yourself to professional standards in this class. Because even professionals sometimes run into conflicts, I will accept **one** late homework assignment and **one** late reading assignment no questions asked, for full credit, provided it is handed in on Canvas within 24 hours of the deadline or handed in to me at the beginning of the next class period. Under special circumstances, you may also get my written (emailed) agreement to hand it in later. Likewise, I will let you resume testing on one abandoned standard (a standard you haven't retested on in over a week) provided it has not been forgotten for 2 weeks or more.

Emailing me with information about absences and late work will help to make sure there's a documentation trail in case I don't remember a verbal conversation.

Students with Disabilities: I am happy to work with students with disabilities. To set up academic adjustments in this class, you should give me a copy of your *Confirmation of Eligibility for Academic Adjustments* from the Disability Support Services Office and come see me in office hours or make an appointment to come see me as soon as possible so we can discuss how the approved adjustments will be implemented in this class. Students without this form should contact the Disability 90Support Services Office, Hogue 126, dssrecept@cwu.edu, https://www.cwu.edu/disability-support/, phone (509) 963-2171. **Testing requests with testing services must be submitted at least 48 hours before an exam is given, or you will have to take the exam with the rest of the class.**

Important Dates

Sept 25	Last day for Add/Drop	Nov 28	Last day to test in office hours
Nov 2	Uncontested Withdrawal Deadline	Nov 30	Last day of class
Nov 12	Veteran's Day (no classes)	Dec 6	Final exam 8-10 am
Nov 21-23	Thanksgiving Holiday (no classes)		

Learning Objectives

1. **(C1R) Counting 1R:** Book: 15-15.7

   a. Students will know and be able to apply the definitions of a function, partial function, injective function, and bijective function in a counting context.

   b. Students will use addition, multiplication, division, and combinations of these operations to count functions, in particular they will be able to count functions, partial functions and injective functions with a given domain and co-domain, including functions with restrictions for certain inputs.

   c. Students will use addition, multiplication, division, and combinations of these operations to solve counting problems.

   d. Students will use permutations and combinations to solve counting problems.

   e. Students will use bijections to solve counting problems.

f. Students will determine which methods mentioned above are appropriate for solving a counting problem, apply these methods and solve.

2. **(C2R) Counting 2R:** Book: 15–15.7, 15.9 –15.9.4
   a. All learning objectives from Counting 1 and
   b. Students will use the principles of inclusion-exclusion to solve counting problems.
3. **(C3) Counting 3:** Book: 15–15.7, 15.8–15.8.2, 15.9–15.9.4
   a. All items from C1R and C2R and
   b. Students will use the Pigeonhole Principle to write a logically valid proof.
4. **(R1) Recurrences 1:** Some ideas on solving recurrences by finding patterns are taken from the book: 22–22.2.
   a. Students find patterns to solve first-order recurrences
   b. Students solve arithmetic and geometric first-order recurrences
   c. Students use the geometric sum formula to solve first-order recurrences
   d. Students apply the solution techniques above to solve application problems involving loans and investments.
5. **(R2R) Recurrences 2R:** Book: 22.3-22.3.2
   a. Students find a solution to a second order homogeneous linear recurrence with constant coefficients ($a_n = Aa_{n-1} + Ba_{n-2}$) using the characteristic equation.
6. **(R3R) Recurrences 3R:** Book: 22.3, A Short Guide to Solving Linear Recurrences
   a. Students find a solution to a second order non-homogeneous linear recurrence with constant coefficients ($a_n = Aa_{n-1} + Ba_{n-2} + Hp^n$) using a characteristic equation and guessing a particular solution.
7. **(R4) Recurrences 4:** Book: 22.3, A Short Guide to Solving Linear Recurrences
   a. Students find the characteristic equation of a higher-order linear recurrence with constant coefficients.
   b. Given a higher-order linear recurrence with constant coefficients, and either roots of the characteristic equation or a homogeneous solution to the recurrence, students will be able to find the form of the particular solution.
8. **(I1R) Induction 1R:** Book: 5.1-5.3. Students will construct a sound proof using strong mathematical induction to show that a given expression is the solution to a second-order homogeneous linear recurrence with constant coefficients.
9. **(I2) Induction 2:** Book: 5.1-5.3. Students will construct a sound proof using either ordinary or strong mathematical induction for problems involving a summation rule like $\forall n \in \mathbb{Z}^+, \sum_{k=0}^{n} k = \frac{n(n+1)}{2}$, a division rule like $\forall n \in \mathbb{N}, 3|(8^n - 5^n)$, or making postage or change like "every amount of postage greater than or equal to 8¢ can be made from a collection of 3¢ and 5¢ postage stamps".
10. **(Num1R) Number Theory 1R:** The material on number bases is not in the book. The Greatest Common Divisor (GCD) and divisibility are covered in the beginning of chapter 9.
    a. Students will use the definition of a numerical base to convert between bases.
    b. Students will be able to reconstruct the definition of the greatest common divisor (GCD), and find the GCD of two or more numbers by prime factorization.
    c. Students will be able to reconstruct the definition of the Least Common Multiple (LCM) and find the LCM of two or more numbers by prime factorization
11. **(Num2R) Number Theory 2R :** Book: 9.2, we read 9.2–9.5
    a. Students use Euclid's Algorithm to finding the GCD of two positive integers, clearly documenting their work and identifying a well-defined stopping condition.
    b. Students use the extended Euclidean Algorithm to find a linear combinations of two positive integers a and b that gives the GCD of a and b.

12. **(Num3R) Number Theory 3R:** Book: 9.6–9.9.2, we read 9.11

    a. Students add, subtract and multiply numbers in $\mathbb{Z}_n$.
    b. Students use fast exponentiation to compute exponential powers in $\mathbb{Z}_n$.
    c. Students use Euclid's extended algorithm to compute multiplicative inverses in $\mathbb{Z}_n$.
    d. Students use multiplicative inverses to solve linear equations in $\mathbb{Z}_n$.

13. **(GT1) Graph Theory 1:** Book: 12–12.4, 12.7, 12.9.

    a. Students prove the Handshaking Lemma and several extensions of the handshaking lemma.
    b. Students draw examples of commmon graphs such as complete, cycle and line graphs.
    c. Students determine if two graphs are isomorphic, giving a reason if they are not and giving the isomorphism if they are.
    d. Students state definitions of walks, paths, and cycles, and identify examples that differentiate between them.
    e. Students state definitions of Hamilton Circuits and Euler Circuits.
    f. Students identify Hamilton or Euler Circuits in an example graph, or explain why there are none.

14. **(GT2) Graph Theory 2:** Book: 12.5

    a. Students use the bipartite matching algorithm known as the mating ritual and correctly document their work to find stable matchings benefitting a given group.
    b. Students use the bipartite matching algorithm to determine whether a stable matching is unique.
    c. Students identify a rogue couple in an unstable matching to demonstrate that it is unstable.

15. **(GT3) Graph Theory 3:** Book: 12.6

    a. Students take a problem involving conflicts between items and create a graph in which the items are the vertices and the edges are the conflicts.
    b. Students find a minimal coloring for a graph and solve the conflict problem using the coloring.

16. **(Net1) Networks 1:** Book: 11–11.3

    a. Students define a routing problem in a network.
    b. Students find a solution to a routing problem in a given network.
    c. Students apply the definition of network diameter to determine the diameter of a given network.
    d. Students apply the definition of network congestion to determine the congestion of a given network, and students will justify their answer by giving a routing problem with this congestion.

17. **(Net2) Networks 2:** Book: 11-11.3, especially 11.3.2

    a. Students recursively construct a butterfly network of a given size.
    b. Students compute the diameter and congestion of a butterfly network of a given size.
    c. Students route information through a butterfly network given a routing problem.
    d. Students complete the definition a routing problem for a butterfly network so that it has minimal congestion.

18. **(Net3) Networks 3:** Book: 11-11.3, especially 11.3.3

    a. Students recursively construct a Beneš network of a given size.
    b. Students compute the diameter and congestion of a Beneš network of a given size.
    c. Students route information through a Beneš network using graph coloring; given a routing problem, students give all conflict graphs and colorings that determine their routing.

19. **(PE) Project Euler :** Students use either Python code or handwritten calculation to solve six problems from `http://projecteuler.net`, problems 4, 5, 7, 15, 67 and 25. Problems 5, 7, 15 and 25 overlap with the required standards. Project Euler is completed at home, with due dates on its sub-parts throughout the quarter.