Welcome to Math 330 Discrete Math – Spring 2020
ONLINE

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Office hours: MWThF 1:20 pm, Tu 7:10 pm and by appointment on BlackBoard Ultra on Canvas times may be modified on Canvas	
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COVID-19 has caused a lot of upheaval in our world in the past weeks. I'm new to online teaching, and you may be new to online learning. I will make mistakes, you will make mistakes, and things will just go wrong. I am going to do my best to help you out when you make mistakes and when things just go wrong. I would appreciate your kind criticism and help when I'm the one who is making mistakes and having things go wrong. I'm trying my best ask you to do things that will be helpful to your learning and that will also create a sense of community for our class. Your constructive criticism and praise are welcome.

Please check in with our course every day and start assignments promptly – the expectation is that you should be spending about 15 hour per week on the course (1 hour class time, 2 hours homework per week day.)

To help me cut down on answering the same question multiple times, please post questions that others might share to the relevant content discussion, or if your question is not covered by a content discussion, please post it to the *Ask an Instructor* discussion on Canvas. I am monitoring discussions daily.

If your question is personal then the best way to contact me is by email (JeanMarie.Linhart@cwu.edu) from your university email address. Please put "[Math 330]" and a descriptive subject in the subject line. I'm really good at following up to email, but I do occasionally put something off for later and forget about it. So if you haven't gotten a response within one business day, please send your question again. **You should also check your university email address daily.**

Please contact me ASAP if you are sick or if there's a reason why you need special consideration or an extension of due dates.

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

Prerequisite: Math 260 with a grade of C or higher.

Technology & support: This is an online course that will rely on the Canvas learning platform. Make an effort to become familiar with Canvas and seek support for technical issues. If you are having technical issues with Canvas, click the Help icon in Canvas to contact the 24/7 support hotline. You will find additional Canvas support and technology requirements on the CWU online learning website (http://www.cwu.edu/online-learning). Additionally the CWU Servie Desk can assist you with MyCWU network and login issues (servicedesk@cwu.edu): 509-963-2001

Text: *Mathematics for Computer Science*, 2015 Edition, by Eric Lehman, F. Thomson Leighton, Albert R. Meyer, available freely for you 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.

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 related learning objectives, called standards, most of which have an associated test or activity, and students must demonstrate their mastery on the test or activity to pass the standard. Students earn a C, B or A for the course based primarily on the number and type of standards they pass. Students may retest on any test-based standard if their first attempt was not successful; the take-home activities may not be repeated.

At the end of the syllabus, you will find the learning objectives for the course separated into 18 standards (this is also on Canvas). Eight of the 18 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. Testing is mastery-based and the grades assigned will be A (40-49, excellent) or B (30-39, very good) or Not Yet (NY, 0-19) passed. On occasion a passing grade of C (20-29) may be assigned.

A table of the requirements for an A, B and C for the course is below. The student will earn the highest grade for which they have completed all of hte requirements in the row.

Course Grade	# of Passed Required	Must Pass	# Other Passed	# of As on Standards	Homework Percent	Other
C	ALL (8)	-	0	0	70+%	
$C+$	ALL (8)	-	1	0	70+%	
$B-$	ALL (8)	-	2	2	75+%	
B	ALL (8)	C3 or R1	2	4	75+%	
$B+$	ALL (8)	C3 or R1	3	6	75+%	
$A-$	ALL (8)	C3 or R1	4	7	80+%	At B or above
A	ALL (8)	C3 and R1	4	8	85+%	At B or above

That last column indicates students earning an $A-$ or an A must pass all of the standards required for that grade with a grade of B or above.

Because of the EP/EF grades this term, the highest grade a student who fails to pass all 8 required standards this term will be a D+. Other than that, as a general rule, each missing requirement from a C grade will reduce the letter grade by $\frac{1}{3}$, i.e. a student with 8 passed required standards, and a homework percent below 70 will get a $C-$ in the course.

Testing and Retesting: Tests should be done using only your brain, a writing implement and paper, and a calculator, unless the directions say otherwise. On challenging material, students must retest, generally a retest will be assigned online and will be due in 2 business days. If there's something going on so that this isn't a workable time-frame for you, please let me know what's going on so that we can figure out an alternative plan.

Some operating parameters

- You may test on C1R and C2R up to 8 times, but can only earn an A on these standards on the first 4 attempts, thereafter the highest grade assigned will be a B.
- You may test on any other required standard 5 times. You can earn an A on any of the first 3 attempts, thereafter the highest grade that can be earned is a B.
- You may test on C3 and R1 up to 4 times, an A can be earned on any of the first 3 attempts.
- You may test on any other optional test-based standard (that is not done as a take-home test) up to 3 times.
- Kryptos, C4, and R5 may not be retaken or handed in late; they are a one-shot deal.
- If you are ready for a test before it ready and up on Canvas, email me to let me know, and I will make an arrangement to get it to you within 2 business days.
- You may attempt to take a test on a standard at most once a day unless special permission is granted.
- Tests are not returned to students, although I am always happy try to answer you questions by email or make another arrangement to go over these with you.
- All tests and assignments for the term should be completed by Wednesday June 10 at noon.

Homework and Discussions: I assign homework to hold you accountable for doing the things that will make you successful in the course. Due dates are to keep you on a schedule so that you will have time to

successfully complete the course. If you are sick or have another special circunstance and need an extension, please ask.

Reading: 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 from the textbook.

Late Policy: Contact me ASAP if you are sick or if there's a reason why you need special consideration of an extension of due dates. Discussion assignments may not be handed in late. All other assignments are subject to a 10% per day penalty for being late, and will not be accepted more than 48 hours after the due date.

Office Hours and Getting Help: Online office hours (using BlackBoard Ultra on Canvas) will be scheduled to make sure there is a time that you can talk to an instructor directly. We also regularly monitor the discussions about course material and the discussion *Ask an Instructor*. Please post questions to these discussions because they can benefit everyone. If you need additional time to talk to an instructor, please email and ask for an appointment to meet in BlackBoard Ultra or via a telephone or Skype call. Please suggest at least 3 possible times that will work for you.

Academic Integrity: All tests are expected to be completed without any resources except those explicitly authorized by the instructor – generally the only resources you have are your brain and a calculator. You are allowed to use the book and notes for C4, R5, and I2R, and you are allowed to discuss C4 with other human beings. 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, unless the assignment instructions state otherwise.

Consult university policies (CWUP 5-90-040(22), CWUR 2-90-040(22), and WAC 106-125-020) for student conduct, cheating, plagiarism, and other academic expectations. CWU's policies and recommendations for academic misconduct will be followed, leading to disciplinary action up to and including failing the course.

Students with Disabilities: Central Washington University is committed to creating a learning environment that meets the needs of its diverse student body. Students with disabilities should contact Disability Services to discuss a range of options to removing barriers, including accommodations: Hogue Hall 126, (509) 963-2214, DS@cwu.edu

Diversity: As a member of a peer learning community, a high degree of professionalism is necessary. CWU expects every member of the university community to contribute to an inclusive and respectful classroom culture.

Mandatory Reporting: I am a mandatory reporter for sexual assault. If you disclose a sexual assault to me, I am required to report it to the University administration.

Important Dates

Students should have passed C1R, C2R, and R2R by the Uncontested Withdrawal Deadline

April 14	Change of schedule period ends	June 10	12 pm All tests for the term must be complete
May 18	Uncontested Withdrawal Deadline		

Learning Objectives

Required standards end in **R**, e.g. C1R is required, C3 is not required.

1. **(C1R) Counting 1R:** Book: 14-14.7
   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: 14–14.7, 14.9 –14.9.4

   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: 14–14.7, 14.8–14.8.2, 14.9–14.9.4

   a. All items from C1R and C2R and
   b. Students will use the Pigeonhole Principle to write a logically valid proof.

4. **(C4) Counting 4:** (Take-home activity) Book: 14–14.7, 14.9–14.9.4

   a. Students solve advanced counting problems using techniques from C1R and C2R that have not been explicitly explained in class.
   b. Students clearly explain the reasoning they use to come up with their solutions using complete sentences and correct mathematical notation.
   c. Students plan ahead to complete work neatly and on-time.

5. **(R1) Recurrences 1:** Some ideas on solving recurrences by finding patterns are taken from the book: 21–21.2.

   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.

6. **(R2R) Recurrences 2R:** Book: 21.3-21.3.2

   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.

7. **(R3R) Recurrences 3R:** Book: 21.3, 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.

8. **(R4) Recurrences 4:** Book: 21.3, 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.

9. **(R5) Recurrences 5:** (Take-home activity) Book: 21.3, A Short Guide to Solving Linear Recurrences

   a. Given a solution to a homogeneous second order linear recurrence with constant coefficients, students explain how to generate the recurrence problem with that solution. E.g. Given $a_n = 3(2^n) + 5(3^n)$, students find a 2nd order linear recurrence with constant coefficients and initial conditions that has this as its solution.
   b. Given a solution to a non-homogeneous second order linear recurrence with constant coefficients, students explain how to generate the non-homogenous recurrence problem with that soltuion. E.g. Given $a_n = 3(2^n) + 5(3^n) + 2(-1)^n$ students find a non-homogenous 2nd order linear recurrence with constant coefficients and initial conditions that has this as its solution.
   c. Students explain ther logic and reasoning using complete sentences.
   d. Students plan ahead to complete work neatly and on-time.

10. **(I1) Induction 1:** Book: 5.1-5.3. Students will construct sound proofs 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".
11. **(I2R) Induction 2R:** (take-home test) 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.
12. **(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
13. **(Num2R) Number Theory 2R :** Book: 8.2, we read 8.2–8.5
    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.
14. **(Num3R) Number Theory 3R:** Book: 8.6–8.9.2, we read 8.11
    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 $\mathbb{Z}_n$.
15. **(GTM) Graph Theory Matching Algorithm:** Book: 11.5
    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.
16. **(GTC) Graph Theory Coloring:** Book: 11.6
    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.
17. **(Net1) Networks 1 Butterfly Networks:** Book: 10–10.8, especially 10.8
    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. **(Net2) Networks 2 Beneš Networks:** Book: 10–10.9, especially 10.9
    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.