**MATH 2420 SECTION 004 DISCRETE MATHEMATICS SYLLABUS**
**FALL 2024 (CRN: 83113)**

**INSTRUCTOR: YONGWEI YAO** **Office**: **1431, 25 PARK PLACE**
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**Office Hours**: **1:00PM--2:30PM, TUESDAYS & THURSDAYS, VIA WEBEX (URL ON ICOLLEGE)**
**COURSE TIME: 2:00--3:15PM, MONDAYS & WEDNESDAYS, AT 104 CLASSROOM SOUTH**

**PREREQUISITE:**
A grade of C or higher in MATH 1113 (Pre-calculus) or Math 1220 (Survey of Calculus)

**REQUIRED TEXT:**
**WebAssign supplemental website:** Signing up for a WebAssign account is a required component of this class since it will be used for assigning graded online homework. Moreover, the entire textbook is available electronically on the website, as well as additional study and review resources. You will be able to register and access WebAssign directly through iCollege. Registering for WebAssign will begin on August 26th.

**TEXTBOOK: (OPTIONAL)**
Discrete Mathematics with Application, 5th Edition, by Susanna Epp (available on WebAssign for free)

**COURSE DESCRIPTION:**
Introduction to discrete structures which are applicable to computer science. Topics include number bases, logic, sets, method of proof, Boolean algebra, counting and probability, elementary concepts of graph theory, and analysis of algorithm efficiency. This is a 3 credit-hour course.

**COURSE CONTENT: Please note that only listed sections will be covered.**
Chapter 1: Speaking Mathematically (1.1, 1.2)
Chapter 2: The Logic of Compound Statements (2.1, 2.2, 2.3)
Chapter 3: The Logic of Quantifies Statements (3.1, 3.2, 3.3, 3.4)
Chapter 4: Elementary Number Theory and Methods of Proof (4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 8.3, 8.4)
Chapter 8: Properties of Relations
Chapter 5: Sequence, Mathematical Induction, and Recursion (5.1, 5.2, 5.4)
Chapter 6: Set Theory (6.1, 6.2)
Chapter 7: Properties of Functions (7.1, 7.2)
Chapter 9: Counting and Probability (9.1, 9.2, 9.3, 9.4, 9.5, 9.6, 9.7, 9.8, 9.9)
Chapter 10: Theory of Graphs and Trees (10.1, 10.2)
Chapter 11: Analysis of Algorithm Efficiency (11.1, 11.2)

MATH 2420 is a Core IMPACTS course that is a part of the Mathematics and the Technology, Mathematics, and Sciences (STEM) areas.

Core IMPACTS refers to the core curriculum, which provides students with essential knowledge in foundational academic areas. This course will help students master course content, and support students' broad academic and career goals.

This course should direct students toward the following broad Orienting Questions:

- How do I measure the world?
- How do I ask scientific questions or use data, mathematics, or technology to understand the universe?

Completion of this course should enable students to meet the following Learning Outcomes:

- Students will apply mathematical and computational knowledge to interpret, evaluate, and communicate quantitative information using verbal, numerical, graphical, or symbolic forms.
- Students will use scientific methods and laboratory procedures or mathematical and computational methods to analyze data, solve problems, and explain natural phenomena.

Course content, activities, and exercises in this course should help students develop the following Career-Ready Competencies:

- Information Literacy
- Inquiry and Analysis
- Problem-Solving
- Teamwork

**COURSE ASSESEMENT:**

a. Tests (45%): There will be three tests throughout the semester. Each test will contribute 15% to your course grade. Students will have to complete the test within 1 hour and 15 minutes.

b. Online homework (15%): There will be online homework assignments on WebAssign throughout the semester. Two lowest homework grades will be dropped.

c. Quizzes (20%): There will be several types of quizzes in this course: on WebAssign, in class, and/or on iCollege. In the end of the semester, two lowest quiz grades will be dropped, and the average of the remaining quizzes will contribute 20% to your course grade.

d. Final Exam (20%): The comprehensive final exam will be given in the classroom. The final exam is scheduled on **Wednesday, December 11$^{th}$, from 1:30 to 4:00pm**. Absence from the final exam will result in a grade of **F** for the course. If the final exam grade is better than your lowest test grade, then that test grade will be replaced by the final exam grade.

**Grading Scale:** 97-100%----A+; 93-96 %----A; 90-92%----A-; 87-89%----B+; 83-86%----B; 80-82%----B-; 77-79 %----C+; 70-76%----C; 60-69%----D; 0-59%----F.

**MAKE UP POLICY:**

**NO** MAKE UP FOR HOMEWORKS, QUIZZES or ANY ASSIGNMENTS THAT WILL BE GIVEN OR COLLECTED.
**NO** make up for the final exam. Absence from the final exam will result in a grade of F for the course.

Policy for makeup of the tests:

- Students must contact the instructor before the test is given and provide official documents for the excuse, and the makeup test must be completed within 3 days.
- No makeup after 3 days of the test is given.

**STUDENT CODE OF CONDUCT STATEMENT**
The university's disruptive student policy applies, and students should familiarize themselves with the relevant parts of the student code of conduct at: http://codeofconduct.gsu.edu/."

**UNAUTHORIZED PUBLIC POSTING AND DISTRIBUTION:**
The selling, sharing, publishing, presenting, or distributing of instructor-prepared course lecture notes, videos, audio recordings, or any other instructor-produced materials from any course for any commercial purpose is strictly prohibited unless explicit written permission is granted in advance by the course instructor. This includes posting any materials on websites such as Chegg, Course Hero, OneClass, Stuvia, StuDocu and other similar sites. Unauthorized sale or commercial distribution of such material is a violation of the instructor's intellectual property and the privacy rights of students attending the class and is prohibited. Failure to abide by these limitations constitutes a violation of the Policy on Academic Honesty and will be treated accordingly.

**COMMUNICATION POLICIES:**
Since we will be working with one another at a distance, it is important for us to have an efficient and effective means to communicate. I will be monitoring my email and the course site on a daily basis and will respond to questions as soon as possible. Please note the following email guideline for this course. Emails will be returned within a 24 hour period. Over a weekend, allow 48 hours for a response. All emailing will be done through iCollege or your GSU email. Or you may come to talk to me during office hours on Webex listed at the top of syllabus.

**WITHDRAWAL DATE:**
The last day to withdraw from class and be eligible for a grade of "W" is **5pm, October 15th, 2024**.

**OTHER FACULTY-INITIATED WITHDRAWL:** If you stop attending the course before the semester midpoint (5pm, October 15th, 2024), you may be administratively withdrawn from the course and receive a withdrawal grade. Attending the course implies consistent class attendance and active involvement both on iCollege and on WebAssign. Failure to meet the following requirements will be considered as lack of attendance:

1. If you do not attend any of the class periods during the first two weeks of the semester, you may be administratively withdrawn from the class for non-attendance.
2. If you do not register for WebAssign during the first two weeks of the semester, you may be administratively withdrawn from the class for non-attendance.

**ACADEMIC HONESTY POLICY:**

Cheating/plagiarism will not be tolerated in any work. A first occurrence will result in a grade of 0 on the assignment for all concerned parties as well as an Academic Dishonesty form being filed with the Dean of Students. A second occurrence will result in a grade of F for the course for the concerned parties and a second Academic Dishonesty form being filed. (See also the University's policy on Academic Honesty at http://codeofconduct.gsu.edu/.)

**ATTENDANCE AND PARTICIPATION POLICY:**
Your attendance and participation in this class are vital to your learning and to your success in the course.

**ACCOMMONDATIONS:**

Students who wish to request accommodation for a disability may do so by registering with the Access & Accommodations center (formerly, Disability Service), Email: access@gsu.edu, Web: https://access.gsu.edu/, Phone: 404-413-1560. Students may only be accommodated upon issuance by the Office a signed Accommodation Plan and are responsible for providing a copy of that plan to instructors of all classes in which accommodation is sought. Students eligible for extra time will be given additional time for the tests as indicated in the Letter of Accommodation. However, no additional arrangement will be made for the online assignments as this privilege is already incorporated in the online assignments.

**COURSE EVALUATION AND EVOLUTION:**
Your constructive assessment of this course plays an indispensable role in shaping education at Georgia State. Upon completing the course, please take the time to fill out the online course evaluation.

**IMPORTANT DATES:**

- Test-1: Monday, Sep. 30th, 2024
- Midpoint: Oct. 15th, 2024
- Test-2: Wednesday, Oct. 23rd, 2024
- Test-3: Wednesday, Nov. 20th, 2024
- Thanksgiving (no classes): Nov. 25-29, 2024
- MATH 2420 Final Exam: **Wednesday, December 11th, from 1:30 to 4:00pm**.

*The course syllabus provides a general plan for the course; deviations may be necessary.*

**MATH 2420 Curriculum**

| | Sections |
|---|---|
| Chapter-1 Speaking Mathematically | 1.1**Variables:** Using Variables in Mathematical Discourse; Introduction to Universal, Existential, and Conditional Statements<br>1.2 **The Language of Sets:** The Set-Roster and Set-Builder Notations; Subsets; Cartesian Products; |

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|---|---|
| | Strings |
| Chapter-2 The Logic of Compound Statements | 2.1 **Logical Form and Logical Equivalence:** Logic Form and Equivalence – statements, compound statements, truth values, logical equivalence, tautologies and contradictions<br>2.2 **Conditional Statements:** Conditional Statements, Negation, Contrapositive, Converse, and Inverse of Conditional, Only if and Biconditional, Necessary and Sufficient Conditions<br>2.3 **Valid and Invalid Arguments:** Modus Ponens, Tollens, Rules of Inference, Fallacies, Contradictions and Valid Arguments |
| Chapter-3 The Logic of Quantified Statements | 3.1 **Predicates and Quantifies Statements I:** Universal Quantifiers, Existential Quantifiers, Formal vs Informal Language, Universal Conditional Statements, Equivalent Forms of Universal and Existential Statements, Implicit Quantification<br>3.2 **Predicates and Quantifies Statements II:** Negation of Quantified Statements, Negation of Universal Conditional Statements, Relations among for all – there exists – and – or, Vacuous Truth of Universal Statements, Variants of Universal Conditional Statements, Necessary and Sufficient Conditions and Only if<br>3.3 **Statements with Multiple Quantifiers:** Multiple Quantifiers, Translating Informal to Formal, Negations with more than one quantifier<br>3.4 **Arguments with Quantifies Statements:** Universal Modus Ponens, Universal Modus Tollens, Applications in Proofs, Using Diagrams to Test Validity |
| Chapter-4 Elementary Number Theory and Methods of Proof | 4.1 **Direct Proof and Counterexample I:** Even – Odd – Prime – Composite Integers, Proving and Disproving Universal statements<br>4.2 **Direct Proofs and Counterexample II**: Writing Advice<br>4.3 **Direct Proof and Counterexample III:** Rational Numbers<br>4.4 **Direct Proofs and Counterexample IV**: Divisibility<br>4.5 **Direct Proofs and Counterexample V**: Division into Cases and the Quotient-Remainder Theorem<br>4.6 **Direct Proof and counterexamples VI**: involving floor and ceiling, div and mod<br>8.3: **Congruence Modulo n**<br>8.4: **Modular Arithmetic:** Modular equivalences, modular arithmetic properties |
| Chapter-5 Sequences, Mathematical Induction, and Recursion | 5.1 **Sequences:** Explicit Formulas for Sequences; Summation Notation; Product Notation; Properties of Summations and Products; Change of Variable; Factorial and n Choose r Notation<br>5.2 **Mathematical Induction I: Proving Formulas:** Principle of Mathematical Induction; Sum of the First n Integers; Proving an Equality; Deducing Additional Formulas; Sum of a Geometric Sequence<br>5.4 Strong Mathematical Induction |
| Chapter-6 Set Theory | 6.1 **Set Theory: Definitions and the Element Method of Proof:** Set Theory, Subsets, Equality, Operations, Power Sets, Partitions, Empty Set<br>6.2 **Properties of Sets:** Proving a subset Relation, set identities, empty set |
| Chapter-7 Properties of Function | 7.1 **Functions Defined on General Sets:** Function properties, arrow diagrams, boolean functions, well-defined, functions acting on sets<br>7.2 **One-To-One, Onto, Inverses, Functions:** on Infinite Sets, Relations between exponential and logarithmic, one-to-one correspondence |
| Chapter-9 Counting and Probability | 9.1 **Introduction to Probability:** Equally likely events<br>9.2 **Possibility Trees and the Multiplication Rule:** Multiplication rule, permutations of an object around a circle, r-permutations<br>9.3 **Counting Elements of Disjoint Sets:** The addition rule, the difference rule, inclusion/exclusion rule<br>9.4 **The Pigeonhole Principle**<br>9.5 **Counting Subsets of a Set:** r-combinations, permutations with sets of indistinguishable objects<br>9.6 **r-Combinations with Repetition Allowed**<br>9.7 **Pascal's Formula and the Binomial Theorem**<br>9.8 **Probability Axioms and Expected Value:** probability axioms and expected value, probability of a general union of two events, complement rule<br>9.9 **Conditional Probability, Bayes' Formula, and Independent Events:** conditional probability, tree diagrams, Bayes' Formula, Independence, general multiplication rule |
| Chapter-10 | 10.1: **Trails, Paths, Circuits:** definitions, subgraphs, connectivity, Euler circuit, Euler trail<br>10.2: **Matrix representations of graph:** matrix operations, matrices for directed and undirected |

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|---|---|
| | graphs (if time allowed) |
| Chapter-11 Analysis of Algorithm Efficiency | 11.1 **Real-Valued Functions of a Real Variable and Their Graphs:** power functions, graphs of multiples of functions, increasing and decreasing functions<br>11.2 **Big-O, Big-Omega, and Big-Theta Notations:** Analysis of Growth rate of functions |

As a result of completing the course Discrete Mathematics, MATH 2420, students will be able to:

1. Identify logical form, form compound statements using the connectives and, or and not, determine truth tables of more general compound statements, determine whether two statement forms are logically equivalent or nonequivalent, apply De Morgan's laws to form negations of "and" and "or", determine whether a statement is a tautology or a contradiction, and use logical equivalences to simplify statement forms.

2. Determine truth tables for compound statements containing conditional and biconditional connectives, represent if-then as or, and then use this representation to negate an if-then statement, determine the negation, contrapositive, converse and inverse of a conditional statement, rewrite a conditional statement as an "only if" statement, and as sufficient and necessary conditions.

3. Determine whether and argument is valid or invalid, use valid argument forms such as modus ponens, modus tollens, etc. to do complex deductions, and illustatrate a proof by contradiction using the knights and knaves example.

4. Determine whether a relation is a function or not. Determine domain, co-domain and range of functions on discrete sets. Determine whether a function is one-to-one, or onto. Determine the existence of inverse functions.

5. Represent a binary (hexadecimal, octal) number as a decimal number, represent a decimal (hexadecimal, octal) number in binary notation, represent a binary number in hexadecimal (octal) notation, and add and subtract binary numbers.

6. Determine the domain and the truth set of a predicate variable, identify universal and existential statements, be able to write these statements in formal and informal language, and identify universal conditional statements, negate universal and existential statements, as well as statements containing both universal and existential statements.

7. Define an even (odd) integer, prove an existential statement using an example, use a direct proof to prove universal statements such as "The sum of an even integer and an odd integer is odd", "If the difference of any two integers is odd, then so is their sum", etc., disprove a universal statement by an example, follow the directions for writing proofs of universal statements, and identify common mistakes in proving statements.

8. Use direct proofs or counterexamples to prove or disprove statements involving the rational numbers.

9. Use direct proofs or counterexamples to prove or disprove statements involving the divisibility of integers, and use the quotient remainder theorem to illustrate a proof by division into cases.

10. Use methods of proofs by contradiction and contraposition to prove various statements.

11. Find the explicit formula for a sequence, and be able to do calculations involving factorial, summation and product notations.

12. Be able to prove statements using mathematical induction.

13. Determine whether one set is a subset of another, whether two sets are equal, whether an element is in a set or not, be able to determine the union, intersection, difference and complement of sets, illustrate sets using Venn diagrams, determine the Cartesian product of two or more sets, prove set identities, use set identities to derive new set properties from old set properties, use Venn diagrams to prove set identities, determine whether sets form a partition of a given set, and determine the power set of a set.

14. Determine whether a relationship is a function or not, determine the domain, co-domain, range of a function, and the inverse image of x, prove or disprove whether a function is one-to-one or not, determine whether a function is onto or not, determine the inverse of a one-to-one correspondence, determine the composition of two functions, and show that if two functions are one-to-one (onto) so too is their composition.

15. Determine the arrow diagram of a relation, whether a relation is a function or not, determine the inverse of a relation, whether a relation is reflexive, symmetric or transitive, determine the transitive closure of a relation, show that the binary relation induced by a partition is an equivalence relation, and show that the set of equivalence classes of an equivalence relation on A forms a partition of A.

16. Identify loops, parallel edges, etc. in a graph, draw the complete graph on n vertices, and the complete bipartite graph on (m, n) vertices, determine whether a graph is bipartite or not, list all the subgraphs of a given graph, determine the degree of a vertex in a graph, prove that the sum of the degrees of the vertices is equal to twice the number of edges, show that in any graph there is an even number of vertices of odd degree, apply these results, and determine the complement of a simple graph.

17. Determine whether a walk is a path, simple path, closed walk, circuit or a simple circuit, determine whether a graph is connected or not, prove that a graph has an Euler circuit if and only if the graph is connected and every vertex of the graph has even degree, determine whether a given graph has an Euler circuit and, if so, indicate one, prove that a graph has an Euler path if and only if the graph is connected and has exactly two vertices of odd degree, determine whether a given graph has an Euler path and, if so, indicate one, and determine whether a graph has a Hamiltonian circuit and, if so, indicate one.

18. Determine whether a graph is a tree or not, show that any tree with more than one vertex has two leaves, show that any tree with n vertices has n-1 edges, show that if G is an connected graph with n vertices and n-1 edges, then G is a tree, determine in a rooted tree, the root, level of a given vertex, height of the tree, children, parent, siblings, ancestors and descendants of a vertex, determine whether a given tree is a binary or full binary tree, and prove results regarding binary trees.

19. Apply Kruskal's algorithm or Prim's algorithm to determine a minimal spanning tree for a given graph.

# Math 2420 Fall 2420 Pacing Calendar

| | Date | Monday | Wednesday |
|---|---|---|---|
| Week-1 | 8/26-8/30 | Syllabus, 1.1, 1.2 | 2.1 |
| Week-2 | 9/2-9/6 | Holiday (no class) | 2.2, 2.3 |
| Week-3 | 9/9-9/13 | 3.1, Quiz 1 | 3.2, 3.3 |
| Week-4 | 9/16-9/20 | 3.3, 3.4, Quiz 2 | 4.1 |
| Week-5 | 9/23-9/27 | 4.2, Quiz 3 | 4.3, 4.4 |
| Week-6 | 9/30-10/4 | Exam 1 (Chapters 1-3, 4.1, 4.2) | 4.5, Quiz 4 |
| Week-7 | 10/7-10/11 | 4.6+8.3/8.4 | 5.1, 5.2, Quiz 5 |
| Week-8 | 10/14-10/18 | 5.2, 5.4 | 6.1, 6.2, Quiz 6 |
| Week-9 | 10/21-10/25 | 7.1, 7,2 | Exam 2 (Chapters 4-6) |
| Week-10 | 10/28-11/1 | 7.2 | 9.1, 9.2, Quiz 7 |
| Week-11 | 11/4-11/8 | 9.3, 9.4, 9.5 | 9.6, 9.7, Quiz 8 |
| Week-12 | 11/11-11/15 | 9.8, 9.9 | 10.1, 10.2, Quiz 9 |
| Week-13 | 11/18-11/22 | 10.2 | Exam 3 (Chapters 7-10) |
| Week-14 | 11/25-11/29 | Thanksgiving Break | |
| Week-15 | 12/2-12/6 | 11.1, 11.2, | 11.2, Quiz 10 |
| Week-16 | 12/9 -12/13 | Review, etc. | Final exam (Dec. 11th), 1:30-4:00pm |