Las Positas College
3000 Campus Hill Drive
Livermore, CA 94551-7650
(925) 424-1000
(925) 443-0742 (Fax)

Course Outline for MATH 10

DISCRETE MATHEMATICS

Effective: Spring 2008

I. CATALOG DESCRIPTION:
MATH 10 — DISCRETE MATHEMATICS — 4.00 units

Designed for majors in mathematics and computer science, this course provides an introduction to discrete mathematical structures and their applications, including: propositional and predicate logic; rules of inference; quantifiers; elements of integer number theory; set theory; methods of proof; induction; combinatorics and discrete probability; functions and relations; recursive definitions and recurrence relations; elements of graph theory and trees. Applications include: analysis of algorithms, Boolean algebras and digital logic circuits.

4.00 Units Lecture

Prerequisite
MATH 1 - Calculus I
with a minimum grade of C

Grading Methods:
Letter Grade

Discipline:

	MIN
Lecture Hours:	72.00
No Unit Value Lab	18.00
Total Hours:	90.00

II. NUMBER OF TIMES COURSE MAY BE TAKEN FOR CREDIT: 1

III. PREREQUISITE AND/OR ADVISORY SKILLS:

Before entering the course a student should be able to:

A. MATH1
1. Evaluate the limit of a function at a real number;
2. Determine whether a function is continuous at a point or an interval;
3. State the definition of the derivative as the limit of a difference quotient and use the definition to find the derivative of a function;
4. Use calculus-based methods to analyze functional behavior;
5. Sketch the graphs of algebraic, rational and transcendental functions using the methods of calculus;
6. Find all maxima, minima and points of inflection of a function;
7. Evaluate the limit of a function at infinity;
8. Apply the Mean Value Theorem;
9. Evaluate a definite integral as the limit of a Riemann sum;
10. Apply the Fundamental Theorem of Integral Calculus;

IV. MEASURABLE OBJECTIVES:

Upon completion of this course, the student should be able to:

A. Construct truth tables;
B. Simplify and negate propositions and quantified predicates;
C. Use rules of inference to determine the validity of a logical argument;
D. Apply principles of propositional logic to Boolean algebras and simplification of digital logic circuits;
E. Use both direct and indirect proof techniques including proof by cases, proof by contraposition and proof by contradiction;
F. Write formal proofs using complete English sentences and principles of logic, rules of inference and quantification;
G. Describe the time complexity of an algorithm using big-O notation;
H. Use the Principle of Mathematical Induction to prove statements about sequences, series and algorithms;
I. Apply principles and definitions of set theory to find unions, intersections, set complement and prove statements about sets;
J. Solve counting problems and determine the probability of an event using elementary counting techniques (Sum and product rules; combination and permutation; principle of inclusion/exclusion);
K. Write a recurrence relation to model a sequence and use recurrence relations to analyze the complexity of divide-and-conquer algorithms;
L. Represent a relation in both graphical and set forms; determine if a relation is an equivalence relation or a partial order relation; find the equivalence classes of an equivalence relation; draw the Hasse diagram of a partial order relation;

M. Prove or disprove a function is one-to-one or onto; find the composition of functions; find the inverse of function;
N. Demonstrate a knowledge of basic graph theory terminology; apply graph theory to shortest path problems;
O. Use properties of trees to solve sorting problems; find minimum spanning trees;
P. Find the input/output table of a Boolean function; find the sum-of-products expansion of a Boolean function; construct the combinatorial circuit of a Boolean function; determine the Boolean function represented by a table or combinatorial circuit.

V. CONTENT:
- A. Propositional logic
  1. Conjunction, disjunction, conditional, biconditional
  2. Logical equivalences
  3. Simplification and negation of propositions
  4. Truth Tables
  5. Rules of inference
- B. Predicate logic
  1. Quantifiers; truth value of quantified predicates
  2. Negation
- C. Methods of proof
  1. Direct proof
  2. Proof by cases
  3. Proof by contraposition
  4. Proof by contradiction
  5. Counterexample
- D. Induction
  1. Principle of mathematical induction
  2. Strong mathematical induction
  3. Well-ordering principle
- E. Elements of integer number theory
  1. Floor and ceiling functions
  2. Divisibility
  3. Quotient-Remainder Theorem
  4. Euclidean algorithm; Division algorithm
- F. Sets and set operations
  1. Construction of sets
  2. Properties of sets
  3. Proofs
- G. Fundamentals of counting and discrete probability
  1. Sum and product rules
  2. Permutations and combinations
  3. Principle of inclusion/exclusion
  4. Use of proof techniques in combinatorics
  5. Finding the probability of an event
- H. Binary relations
  1. Representation of relations
     a. Set representation
     b. Graphical representation
  2. Closure
  3. Equivalence relations and equivalence classes
  4. Partial order relations and Hasse diagrams
- I. Sequences and functions
  1. Definition of function
  2. One-to-one and onto functions; bijections
  3. Composition of functions
  4. Inverse functions
- J. Recursive definitions and recurrence relations
  1. sequences
- K. Complexity of algorithms
  1. Growth of functions (big-0 analysis)
  2. Divide and conquer algorithms
- L. Graph theory
  1. Definitions and representation of graphs
  2. Connectivity
  3. Euler and Hamilton paths
  4. Shortest path problems
  5. Planar graphs.
- M. Trees
  1. Definitions and applications
  2. Traversal and sorting
  3. Minimum spanning trees.
- N. Boolean algebras and digital logic circuits
  1. Definition and properties
  2. I/O tables
  3. Logic gates
  4. Sum-of-products expansion
  5. Simplification of circuits

VI. METHODS OF INSTRUCTION:
- A. **Lecture** -
- B. **Demonstration** -
- C. Writing assignments
- D. Problem solving laboratory 1. Individual work on assigned problems 2. Collaborative learning activities
- E. Classroom discussion

VII. TYPICAL ASSIGNMENTS:

A. Homework assignments 1. Assigned homework problems are usually from the textbook and include a mix of computational and theoretical work. Homework should take an average student 1 to 2 hours for each hour in class. B. Problem solving laboratory. During the problem solving laboratory students work individually or in teams to solve problems related to the course material. Examples of the types of assignments given are: 1. Quantified Predicates: Given a quantified predicate, write the negation of the statement and determine which is true, the original statement or its negation. Give a

proof or counterexample, as appropriate. 2. Digital Logic Circuits and I/O Tables: The lights in a classroom are controlled by two switches: one at the back and one at the front of the room. Moving either switch to the opposite position turns the lights off if they are on and on if they are off. Assume the lights have been installed so that when both switches are in the down position, the lights are off. Design a circuit to control the switches and construct the I/O table and Boolean expression for the circuit. 3. Fibonacci Sequence: Male bees, which have a mother but no father, hatch from unfertilized eggs. Female bees hatch from fertilized eggs. How many ancestors does a male bee have in the tenth generation back? How many of these ancestors are male? C. Writing Assignments Writing assignments can be short research papers or expository writing assignments which allow the students to delve more deeply into a particular area of interest. 1. As an example, the instructor might provide students with a list of notable pioneers in the field of Discrete Mathematics (e.g., Lady Ada Lovelace, Augustus DeMorgan, Claude Shannon, Alan Turing) and ask each student to prepare a 2-3 page biography of one of the persons on the list. Five minutes could be set aside each class for one student to present a brief synopsis of the life of their chosen person.

VIII. EVALUATION:

A. **Methods**

1. Exams/Tests
2. Quizzes
3. Papers
4. Home Work
5. Other:
    a. Methods
        1. Examinations
        2. Quizzes
        3. Homework
        4. Collaborative or Individual Learning Activities
        5. Writing Assignments

B. **Frequency**

1. Frequency of evaluation
    a. Recommend three or four exams plus a comprehensive final examination
    b. Quizzes at the discretion of the instructor
    c. Homework for each section covered
    d. Recommend weekly collaborative or individual learning activities
    e. Recommend minimum of two writing assignments

IX. TYPICAL TEXTS:

1. Rosen, Kenneth H *Discrete Mathematics and Its Applications.* 6th ed., WCB McGraw-Hill, 2007.
2. Epp, Susanna S *Discrete Mathematics with Applications.* 3rd ed., Brooks/Cole – Thompson Learning, 2004.
3. Grimaldi, Ralph P *Discrete and Combinatorial Mathematics.* 5th ed., Addison Wesley, 2004.

X. OTHER MATERIALS REQUIRED OF STUDENTS:

A. A calculator with combinatorial functions.