1 Warning

Community College of Philadelphia is a firm adherent to the principle of academic freedom. In light of this, faculty are not required to follow a particular approach or a particular textbook for the courses they teach. Most faculty, however, have more or less uniform guidelines for specific courses, and indeed, many use a particular textbook or approach in order to conform to area institutions. Therefore, the sample syllabus found here is not binding to faculty, but represents a synthesis of what most faculty do or aspire to do when they teach a particular course. What follows should not be interpreted as a prescription, but rather, as a means to help the placement of our students in transfer institutions.

2 Catalogue Description

Set theory, algebraic structures, combinatorics, graphs and trees. elements of logic, Boolean algebra and theory of proofs. Introduction to theory of algorithms. Applications in computer science. Prerequisite: MATH 161 or MATH 162 or higher placement.

3 Allotted Time

Math 163 is a four credit course. Thus it meets for $\mathbf{4} \times \mathbf{14} = \mathbf{56}$ hours in a semester, including two hours for a final examination. Instructors usually give three or four exams (generally lasting at least **55** minutes), and a **2**-hour long final exam.

4 Topics Outline

- Pseudocode: Variable Types. Arrays. Operators. `for{}`, `if{}else{}`, `while{}`
- Pseudocode: Algorithms. Propositions and Logic. Predicates and Quantifiers.
- Some elementary methods of proof. Mathematical Induction. More examples of Induction.
- Set Theory. Boolean Algebra. Karnaugh Maps. Logic Circuits.
- The Integers and the Euclidean Algorithm. Representations of integers in different bases. Number Theoretic Functions. Congruences.
- Sums and Recurrences.
- Relations and Functions. Chapter 6: Inclusion-Exclusion. Multiplication Rule. Addition Rule. Chapter 6: Permutations and Combinations. Distributions.
- Graphs and Directed Graphs.

5 Competencies

The student will learn:

1. to work with basic concepts and techniques of logic, set theory and functions
   (a) Students will understand the notion of proposition.
   (b) Students will use properties of logical connectives and truth tables to determine a truth value of a compound proposition.
   (c) Students will prove or disprove logical equivalencies.
   (d) Students will use quantifiers and predicates to express statements.
   (e) Students will prove set identities by a membership table and/or by use of basic set identities.
   (f) Students will apply Venn diagrams to represent subsets, unions, intersections and complements of sets.
   (g) Students will construct Cartesian products of sets.
   (h) Students will review the basic concepts involving functions .

(i) Students will determine the domain and codomain of a function.

(j) Students will analyze properties of functions such as injectivity, surjectivity and invertibility.

2. the basic techniques and principles of counting.

   (a) Students will apply principles of multiplication and addition to count elements of sets.

   (b) Students will draw tree diagrams to list elements of sets.

   (c) Students will apply the pigeonhole principle to attack existence problems.

   (d) Students will apply and compute numbers of permutations and combinations for solving counting problems.

   (e) Students will construct discrete probability models and compute discrete probabilities.

   (f) Students will apply advanced counting techniques such as generalized permutations and combinations for solving counting problems.

   (g) Students will use the sieving techniques of the Sylvester-Poincaré Inclusion-Exclusion Principle in order to count sets.

3. to understand recursion.

   (a) Students will construct recursively defined sequences including the Fibonacci sequence.

   (b) Students will understand and construct proofs by induction.

   (c) Students will solve homogeneous linear recurrence relations with the help of the auxiliary equation.

   (d) Students will solve linear recurrence relations with initial conditions.

4. to work with relations and digraphs.

   (a) Students will understand the notion of relation.

   (b) Students will identify properties of relations such as symmetry, antisymmetry, reflexivity, and transitivity.

   (c) Students will represent relations using digraphs.

   (d) Students will recognize equivalence relations and find the classes of equivalence.

   (e) Students will apply the notion of equivalence relation to modular arithmetic and congruences.

5. basic properties of graphs and trees

   (a) Students will understand the basic definitions of graphs and different types of graphs including connected graphs.

   (b) Students will understand the definition of isomorphism between two graphs and recognize isomorphic graphs.

   (c) Students will understand the notion of tree and spanning tree.

6. to work with such structures as Boolean algebra, logic circuits and power sets.

   (a) Students will understand the basic definitions of Boolean variables and functions.

   (b) Students will practice with basic Boolean operations: sum and product, and complement.

   (c) Students will prove Boolean identities and construct new identities from old ones using the duality principle.

   (d) Students will use an abstract definition to analyze relationships between propositional logic and algebra of sets.

   (e) Students will construct circuits using logic gates.

   (f) Students will apply Karnaugh maps and the Quine-McCluskey Method for minimization of circuits.

(g) Students will recognize and develop applications of Boolean Algebra in real situations such as constructing circuits and minimizing Boolean expressions for efficient circuit design.

7. some properties of prime numbers and their applications to encoding and decoding.