# CSI 35 LECTURE NOTES (Ojakian)

## Topic 0: Introduction, Review, and Programming

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**OUTLINE**

(References: Rosen: 3.1)

1. Mathematical Terminology
2. Review and Programming

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1. Math and Computer Science
   (a) Discrete math versus other math
   (b) Algorithm - mathematics in action
   (c) How do we make imprecise world precise for a machine? Logic!
2. General Mathematical Introduction
   (a) Basic development in mathematics:
      i. Definition.
      ii. Theorem (or Lemma or Claim or ...)
      iii. Proof
   (b) Example:
      i. How might you define the terminology "even" and "odd"?
      ii. Theorem: The addition of two evens is even.
   (c) Example:
      i. DEF: a *Word* is any finite sequence of the 26 letters from the English alphabet.
      ii. DEF: Say a word is *BRONX* if its length is odd, its first letter is B and its last letter is X.
      iii. DEF: Given any words, their *concatenation* is the formation of a single word by putting the words one after another.
      iv. Theorems? - Concatenating 2 BRONX words is BRONX? Etc?
   (d)

   **PROBLEM 1.** *1) Make up a simple definition, 2) State a theorem that concerns your definition, and 3) Prove your theorem.*
3. Math to recall
   (a) Integers
   (b) Definition of positive, negative.
   (c) Divisibility
   (d) Prime

4. Terminology about mathematical reasoning

   (a) Theorem, Lemma, Corollary

   (b) Definition (note: some precise definitions omitted in favor of loose description, e.g. the integers)

   (c) Proof

   (d) Example: What is the sum of two evens? Prove it or test it by a program?

   (e) What about the sum of two odds?

5. Algorithms

   (a) An algorithm is a finite set of precise instructions for performing a computation.

      i. Example: multiplication, division, etc.

      ii. Example (dumb): Given any input positive integer, repeatedly subtract 1 till the value is zero, then stop and return the current value (i.e. zero ...)

   (b) Basic Constructs

      i. Assignment statements

      ii. Basic data structure: Lists

      iii. Conditional statements

      iv. For Loops

      v. While Loops

      vi. Loop Applications: Accumulators and Boolean Flags

      vii. Functions with return statement

   (c)

   **PROBLEM 2.** *Supposing $x$ and $y$ are set to integers. Set $z$ to the larger of $x$ or $y$.*

   **PROBLEM 3.** *Write the definition of a function which takes an integer $n$ as input and returns $n$ if $n$ is negative, 0 if $n$ is zero, and $-n$ if $n$ is positive (do with with a conditional statement, and without). Graph it.*

   **PROBLEM 4.** *Write the definition of a function which takes two arguments, the first a negative integer $s$ and the second a positive integer $t$. The function returns the sum of the even integers inbetween $s$ and $t$ (including $s$ and $t$).*

   **PROBLEM 5.** *Do one of the above for-loop questions with a while loop.*

   **PROBLEM 6.**
   *Suppose $x$ and $y$ are integers where $x < y$. Use nested for-loops to print out all the pairs of integers $(a, b)$ where $x \leq a, b, \leq y$.*

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   **PROBLEM 7.** *(boolean flag example) Using a while loop, write a program to check if a integer $n$ is divisible by a integer $d$ (assume $1 \leq d \leq n$). Do without the programming construct: $n\%d$.*

   **PROBLEM 8.** *(boolean flag example) Using a while loop (along with $n\%d$), write a program to find the LCM of some positive integers $A$ and $B$.*

6. Programs Instead of Proofs?

   (a)

   **PROBLEM 9.** *Write program to test the claim: The sum of evens is even (test all pairs of evens up to 100)*

   **PROBLEM 10.** *What do you think the sum of consecutive integers should be? Write a program to test your hypothesis.*

   (b) Do our programs prove the claim? What are the issues?

7. Harder Questions...

   (a) Are there infinitely many prime numbers?

   (b) Are there infinitely many twin primes? (Read Rosen p. 280)

   (c) Goldbach Conjecture?

   (d) Test your hypothesis with a program.

8. Exercises

   Section 3.1: 3, 4*, 13, 14, 16*, 19, 23, 24*

   (where * means maybe hard ..)