CSE 30151 Theory of Computing Fall 2017: Homework 1

Version 2: Aug. 28, 2017

Instructions

- Unless otherwise specified, all problems from book are from Version 3. When a problem in the International Edition is different from Version 3, the problem will be listed as V3:x.yy/IE:x.zz, where x.zz is the equivalent number. If the Internal Edition does not have a matching number, the problem text will be duplicated.
- You can prepare your solutions however you like (handwriting, LaTeX, etc.), but you must submit them in PDF. You can scan written solutions in the library or using a smartphone (with a scanner app like CamScanner). It is up to you to ensure that submissions are legible.
- Please give every PDF file a unique filename.
  - If you're making a complete submission (all problems), name your PDF file `netid-hw1.pdf`, where `netid` is replaced with your `NetID`.
  - If you're submitting some problems now and other problems later, name your file `netid-hw1-123.pdf`, where `123` is replaced with just the problems you are submitting now.
  - If you use the same filename twice, only the most recent version will be graded.
  - The time of submission is the time the most recent file was uploaded.
- If you use latex and want to draw something like a state diagram, consider using the tikz package. A reference document is on the website under "Assignments".
- Submit your PDF file in Sakai. Don't forget to click the Submit (or Resubmit) button!

Practice Problems

These problems are from the book, and most have solutions listed for them. They are listed here for you to practice on as needed and any answers you generate **should not** be submitted. You are free to discuss these with others, but you are not allowed to post solutions to any public forum.

1. Describing and working with sets: 0.1, 0.2, 0.3
2. Graphs: 0.8, 0.9
3. Proofs: (V3:0.12/V2:0.11/IE:0.11) V3:0.14/IE:0.15, V3:0.15/IE:0.14

Book Exercises

These problems are found in the text book and are to be answered and submitted by each student. You are to solve them yourself. Use of solution manuals from any source or shared solutions is a violation of the ND Honor Code. You are also not allowed to show your solutions to another student.

1. (5pt) 0.6

2. (5pt) 0.8
3. (5pt) V3:0.10/IE:0.13
4. (10pt) V3:0.11/IE:0.12 but not in V2: Let $S(n) = 1 + 2 + ...n$ and $C(n) = 1^3 + 2^3 + ... + n^3$. Prove each of the following by induction (together they show $C(n) = S^2(n)$).
   (a) $S(n) = 0.5 * n(n + 1)$
   (b) $C(n) = 0.25 * (n^4 + 2n^3 + n^2) = 0.25 * n^2(n + 1)^2$

Non-book Problems

The following problems are not found in the text book. You are to solve them yourself. Use of any resource you used other than the text book or class notes must be cited. You are also not allowed to show your solutions to another student.

5. (5pt) Include the following statement as your answer: "I have read and understand both the ND Honor Code policy and the CSE Guide to the Honor Code as posted on the class web site. From the latter, I understand that the color for using an on-line solution manual for book problems is": (fill in color red, green, or yellow).
6. (5pt) Prove by contradiction that For all integers n, if n^2 is odd, then n is odd.
7. (5pt) Prove by construction that between any two consecutive powers of 2 2^n and 2^{n+1} where $n > 0$ there is at least one odd number.
8. (10pt) Consider a 1-digit display calculator with just the keys "0" thru "9", "C", "+", "-", and "=". Assume math is all mod 10 so that $9+3 = 2$ and $5-9 = 6$ and that pushing more than one number key leaves only the last one on the display (earlier ones are lost). Assume that at power on, the calculator comes up as if the "C" button had been pushed. Assume also when you type an "=" that the number on the display becomes the new saved number and that the display shows the new computed value using the last operation.

   Describe with either a state diagram, a state table, or a function that describes the state transitions a machine that will run this calculator properly. Describe how many different states are possible. What state is the initial state on power up?

   A suggested notation for naming the states is "ixj" where "i" and "j" are digits 0 to 9 and "x" is the last function button pushed ("C", "+", "-", "="), i is the last digit "saved," and j is the digit currently being displayed. Thus the state "3+2" might be the state after typing C3+2, or 9-6+432. You are free to use some shorthand if you define it clearly, e.g. "*" refers to any state, and "i, j, or k" refers to any digit key. You may also assume that the function "mod10(x)" where x is an integer expression returns the value of x modulo 10. Make sure you account for all possible sequences of button pushes.