Optional Project Morally Due May, 13 11:00AM Dead Cat Day: May 15, 11:00AM

WARNING: The Final is ON May 15 at 10:30AM ADVICE: Hand it in ON the Moral Due Date

This is an OPTIONAL PROJECT. It would be more accurate to say its an OPTIONAL HW. I will not look at it until after the final is graded and the final grades have been determined.

- 1. If you have a D in the course and do a VERY GOOD JOB on the optional project then I will bump your grade to a C-.
- 2. If you have an F in the course and you do a VERY GOOD JOB on the optional project then I will bump your grade to a D.
- 3. The following has actually happened. DON"T BE THIS GUY. A guy does badly on the midterm, does not do the project, gets a D in the course, and THEN asks me if he could do some kind of optional project to bring his grade up to a C. The answer was of course NO. DO NOT BE THAT GUY.
- 4. The following has actually happened. DON"T BE THIS GUY. A guy does a terrible job on the optional project but since he DID IT he thinks that is all he needs for his bump up. It is not. He kept his F.
- 5. Students often ask me for sample problems. Consider this to be a set of sample problems whether you do it or not.
- 6. Should you do this if you are in no danger of failing the course? Yesits a good study aid.
- 7. Can this bump your grade from a C to a B or a B to an A or some such? NO. I will only look at those from the D and F students.

1. (0 points but if you don't answer this one you may get a 0 on the project) What is your name. PRINT CLEARLY

- (a) (5 points) Give an algorithm that will, given an NFA M of size n, return a DFA D such that L(D) = L(M).
- (b) (5 points) Give a function f such that, in the algorithm you just gave, if M has n states then D has O(f(n)) states.

- (a) (5 points) Give an algorithm that will, given a regex α of size n, return an NFA N such that $L(\alpha) = L(M)$.
- (b) (5 points) Give a function f such that, in the algorithm you just gave, if α is of length n then N has O(f(n)) states.

- (a) (5 points) Give an algorithm that will, given a DFA M of sizes n, return a CFG G such that L(G) = L(M)
- (b) (5 points) Give a function f such that, in the algorithm you just gave, if M has n states then G has O(f(n)) rules. (The grammar need not be in CNF.)

5. (10 points) Give an algorithm that will, given t, return a Chomsky Normal Form CFG (we allow $A \to BCD$ and $A \to e$) for the set

$$\{e, a, a^2, \dots, a^{2^t - 1}\}$$

The number of nonterminals has to be O(t).

6. (10 points) Let $L = \{a^i : i \neq 1, 000, 000\}.$

We want an NFA for this language that has substantially less than 1,000,000 states.

DO NOT give me that NFA.

JUST give me the relevant x, y, t and the set of primes that are needed.

How many states does your NFA have?

(Do NOT worry about off-by-1 errors for t or number-of-states.)

GIVE x HERE:

GIVE y HERE:

GIVE t HERE:

GIVE THE PRIMES HERE:

GIVE THE NUMBER OF STATES HERE:

7. (10 points) Consider the following statement

If $L \in NP$ then $\overline{L} \in NP$.

State if it is TRUE, FALSE, or UNKNOWN TO SCIENCE

If you answer TRUE then prove if.

If you answer its FALSE then give a counterexample.

If you answer UNKNOWN TO SCIENCE then you do not need to do anything more.

8. (10 points) Consider the following statement

If $L \in \Sigma_1$ then $\overline{L} \in \Sigma_1$.

State if it is TRUE, FALSE, or UNKNOWN TO SCIENCE

If you answer TRUE then prove if.

If you answer its FALSE then give a counterexample.

If you answer UNKNOWN TO SCIENCE then you do not need to do anything more.

- (a) (5 points) Give a set that is undecidable but does not involve Turing Machines.
- (b) (5 points) Give ANOTHER set that is undecidable but does not involve Turing Machines.

10. (10 points) Give five NP-complete sets.

11. (10 points)

- (a) Give a set A such that the following holds:
 - $A \in NP$.
 - The question is A in P? is UNKNOWN TO SCIENCE!
 - The question *is A in* NP-*complete?* is UNKNOWN TO SCI-ENCE!
- (b) (5 points) Give an algorithm for the set A. It **does not** need to be efficient. It **does** need to be clear enough so that the grader can take what you give and write a program that runs your algorithm.