Notes, book, etc. are not allowed.

Except where otherwise noted, you should always justify your answers. Correct answers with no justification may receive little credit. Incorrect or incomplete answers that display insight often receive partial credit.

It is understood that efficient, concise solutions are usually favored over inefficient or verbose solutions, and hence may earn more points.

If you feel that a problem is ambiguously worded, then ask for clarification. If the problem is still unclear, then explain your interpretation in your solution. Never interpret a problem in a way that renders it trivial.

You have 70 minutes. Good luck.

A. Let A be a finite language — that is, one containing only finitely many strings.

A.A. Prove that A is regular.

A.B. What is the minimal pumping length p for A?

B. Here are eight strings that represent floating-point numbers in a hypothetical programming language. In this context, `e` and `E` mean "times 10 to the power". For example, `5.1e2` and `5.1E2` both represent 510. The power is always an integer.

```
-3.14159  2.0  -7  2.72  2.45733e4  -7e1  -0.14E-6  0.9999999999999989
```

The decimal point is always preceded and followed by a digit. The `e` and `E` are always preceded by a digit and followed by either a digit or `-`. The - is always followed by a digit. Here are eight strings that are not valid numerals.

```
-.14159  2.  -  ϵ  2.e4  -e1  -0.14E-  --0.9999999999999989
```

Write a regular expression that matches floating-point numerals as defined above. Use textbook syntax, not Python syntax. For clarity, please employ a regular sub-expression D that matches the ten digits $\texttt{0}, \texttt{1}, \texttt{2}, \ldots, \texttt{9}$.

C. On these TRUE-FALSE questions there are four valid answers. If the correct answer is TRUE, then TRUE earns 3 points, TRUISH earns 2 points, FALSISH earns 1 point, and FALSE earns 0 points. If the correct answer is FALSE, then these point values are of course reversed. Do not write just T or F; write your answer completely and clearly. No explanation is needed.

C.A. If A is any context-free language, then A^* is also context-free.

C.B. For any CFL A, there exists a PDA P with exactly three states such that $L(P) = A$.

C.C. PDAs are deterministic.

C.D. For any regular language A, there exists a context-free grammar G such that $L(G) = A$.

C.E. For any CFL A, there exists $p \geq 1$ such that, for all $w \in A$ with $|w| \geq p$, there exist strings u, v, x, y, z such that $w = uvxyz$, $|uvx| \leq p$, $|vy| \geq 1$, and $uv^ixy^iz \in A$ for all $i \geq 0$.

D. Let $A = \{0^n 1 0^{2n} : n \geq 0\} \subseteq \{0,1\}^*$. Is A regular? Prove your answer.

E. Let $A = \{a^i b^j c^k : i \geq 0, j \geq 0, k \geq 0, \text{ and } (i \neq j \text{ or } j \neq k)\}$. Draw a PDA for A. Add comments to your drawing, to help me understand it.