NAME:

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NTIN071 A&G: Sample test

Each problem is worth 20 points, totaling 120 points.

1. Construct a context-free grammar generating the language $L = \{a^n b^k a^{3n} \mid n, k \geq 0\}$. Write down a derivation for the word $w = abbaaa$.

2. Prove that the language $L = \{a^{n^5} \mid n \geq 0\}$ is not regular.

3. Construct a pushdown automaton accepting, by empty stack, the language $L = \{w \in \{0,1\}^* \mid |w|_0 \geq |w|_1 + 1\}$. Write down a sequence of configurations for the word $w = 10001$.

4. Prove that the language $L = \{0^i 1^j 2^k 3^\ell \mid i = j = k \text{ or } \ell = 0\}$ is not context-free.

5. Construct a deterministic finite automaton that accepts exactly those words over the alphabet $\{0,1\}$ which end with the sequence 010.

6. Construct a Turing machine that for a given positive integer $x > 0$ in binary encoding outputs its predecessor, i.e., $x - 1$ (in binary encoding as well). Write a sequence of configurations for the input $w = 1010$.