

# Compilers [Spring 2022]

## Test II

NAME: \_\_\_\_\_

### Instructions:

- 1) This test is 7 pages in length.
- 2) You have 75 minutes to complete and turn in this test.
- 3) Short-answer and essay questions will be graded on how clearly you've communicated the necessary ideas. Respond in complete English sentences. Avoid using bullet points and enumerated lists.
- 4) This test is closed books, notes, papers, friends, phones, neighbors, smartwatches, etc.
- 5) Use the backs of pages in this test packet for scratch work. If you write more than a final answer in the area next to a question, circle your final answer.
- 6) Write and sign the following: "I pledge my Honor that I have not cheated, and will not cheat, on this test."

\_\_\_\_\_

\_\_\_\_\_

Signed: \_\_\_\_\_

1. [6 points] [Respond with 1 sentence for each]

a) What is a language?

b) What is a programming language?

c) How does one define/specify a programming language?

2. [20 points]

Describe the data structure and API for ASTs in djc. [Essay]

3. [5 points]

Compare and contrast Bison and ANTLR. [1-2 sentences]

4. [16 points]

a) Given an NFA with  $n$  states, what are the minimum and maximum number of states an equivalent minimized DFA might have?

b) Given a minimized DFA with  $n$  states, what are the minimum and maximum number of states an equivalent NFA might have?

c) Given an NFA with  $n$  states, what are the minimum and maximum number of states an equivalent NFA might have?

d) Given a DFA with  $n$  states, what are the minimum and maximum number of states an equivalent minimized DFA might have?

5. [20 points]

Recall that context-free languages are those that can be specified by a CFG and, equivalently, can be recognized by a pushdown automaton (i.e., “an NFA with a stack”). Write high-level explanations that context-free languages are closed under (a) union and (b) concatenation but are not closed under (c) intersection and (d) complement.

Hint: At some point you may wish to consider  $L_1 = \{0^a 1^a 2^b\}$  and  $L_2 = \{0^a 1^b 2^b\}$  where  $a, b \geq 0$ .

6. G is:  $S \rightarrow A\$$        $A \rightarrow 0A0 \mid 1A1 \mid \epsilon$

a) Considering all the LL sets of grammars we discussed in class, prove which ones (if any) contain G. [15 points]

G is:  $S \rightarrow A\$$        $A \rightarrow 0A0 \mid 1A1 \mid \epsilon$

b) Show (i) an SLR parse table for G and (ii) an SLR parse trace of input 0011\$ according to G. If you arrive at a point in the parse trace where the trace cannot continue, indicate the problem and stop the trace at that point. [18 points]

**Undergraduates stop here. The remaining problem is for graduate students.**

G is:  $S \rightarrow A\$$        $A \rightarrow 0A0 \mid 1A1 \mid \epsilon$

c) Considering all the LR sets of grammars we discussed in class, prove which ones (if any) contain G. [12 points]