Compilers [Spring 2023]
Test III

NAME: ____

Instructions:

1) This test is 10 pages in length.

2) You have 120 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. Respond at the level of detail discussed in class. Use abbreviations and notations used in class.

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."

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Signed: ____

1. [7 points] Describe the symbol-table data structures used in djc. [Essay]

2. [3 points] Define a CFG that is an element of LL(3) but not LL(2).

3. [4 points] Illustrate a nontrivial vtable by defining a valid DJ program and its vtable.

4. [5 points] Order the following from first invented to last invented.
(a) LR parsing (b) TMs (c) lambda calculus (d) bison (e) yacc (f) garbage collection

5. [5 points] Draw a minimum-state DFA recognizing all base-3 numbers that have a remainder of 0 or 3 when divided by 4.

6. [10 points] Draw a picture to show DISM memory while code generated by djc executes. Show all the different kinds of values that can be in memory.

7. [6 points] What are advantages and disadvantages of mark and compact, compared to other GC algorithms?

8. [4 points] Sketch a proof of the “full-employment theorem for compiler writers”.

9. [3 points] Name and illustrate 3 different code optimizations discussed in class.

10. [10 points] [Essay]
As discussed in class, there exist three common ways to implement parsers, two of which involve using special tools. What are the three ways, and what are the tradeoffs between them (e.g., what are the costs and benefits of using one tool versus another)?

11. [18 points] [The following page is blank, to provide additional space to respond.] Recall the LALR problem from Test II, the problem that asked you to determine and show examples for every possible 2-action conflict in an LALR parser. You considered the possibility of shift-shift conflicts, shift-reduce conflicts, shift-accept conflicts, etc. Now solve the same problem but for every possible 3-action conflict. For example, you now have to consider the possibility of shift-shift-shift conflicts. Explain exactly which 3-action conflicts are possible in an LALR parser and why. For every possible 3-action conflict, (a) define an example grammar G that causes an LALR parser to have the conflict, (b) show enough of G's LALR DFA to pinpoint the conflict, (c) define another grammar H equivalent to G, (d) show that H's LALR parse table is conflict free, and (e) show an LALR parse trace of a valid input according to H. For this problem, grammars may not contain a repeated rule and may not contain a rule of the form N ::= N.

[This page provides additional space for Problem 11.]

12. [25 points] [Essay] [The following page provides additional space to respond.] Suppose we add for-loops to DJ. How should our (non-bootstrapped) djc be modified, to implement this new feature? Which files should be modified, and how? As always, respond at the level of detail discussed in class. More efficient implementations, and more efficient target code, will receive more points.

[This page provides additional space for Problem 12.]

Undergraduates stop here. The remaining problems are for graduate students.

13. [8 points]

Sketch a proof of the undecidability of the halting problem.