Compilers [Spring 2024]
Test I

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. Respond at the level of detail discussed in class.

4) This test is closed books, notes, papers, friends, neighbors, laptops, phones, smartwatches, etc.

1. [5 points] [1-4 sentences]
What are some reasons for studying compilers? Hit all the main points discussed in class.

2. [5 points] [1-4 sentences] Compare and contrast compiler front and back ends. Hit all the main points discussed in class.

3. [4 points] [1 sentence] Concisely explain the strings matched by the following RE.
`([ab][ab][ab][ab][ab])*|([ab][ab][ab])*`

4. [16 points] [1-3 sentences for each part]
For each of the following languages, briefly explain whether a DFA accepts that language. Assume m and n are natural numbers.

a) All strings matching 0^m1^n

b) $\{0^m1^n \mid m<n\}$

c) $\{0^m1^n \mid m>10^{10} \text{ and } n>10^{10}\}$

d) $\{0^m1^n \mid m<10^{10} \text{ and } n<10^{10}\}$

5. [20 points] [Just respond to each part with "Min: …" and "Max: …".]

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

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

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

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

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

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

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

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

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

6. [20 points] Draw LL(1) and LL(2) parse tables for the following CFG G.


```
0   S::=A$
1   A::=BABA
2   A::=ε
3   B::=o
```

Notice G∉LL(1), so also rewrite G into an equivalent CFG G' and show that G'∈LL(1).

7. [30 points] Show a GLR parse trace of yxxyxx$ according to the following grammar.

```
0   S::=A$
1   A::=BxA
2   A::=Cx
3   B::=ε
4   C::=ε
5   B::=y
```

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

8. [12 points] Define a CFG such that its LR(0), SLR, LALR, and LR(1) tables are identical and conflict free, and prove it.