Instructions:

1) This test is 5 pages in length.

2) You have 75 minutes to complete and turn in this test.

3) Short answer questions include a guideline for how many sentences to write. Respond in complete English sentences.

4) This test is closed books, notes, papers, friends, neighbors, 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. [5 points]
   What is a compiler? [1 sentence]

2. [5 points]
   Java (unlike DJ) has separate types for booleans and ints, so expressions like 
   \texttt{true == 1} are not allowed. Also, Java allows the expression \texttt{1 == 0 == false == true} 
   but does not allow the expression \texttt{true == false == 0 == 1}. Is the \texttt{==} operator in Java 
   left-associative, right-associative, or non-associative?

3) [45 points]
   a) Draw an NFA that recognizes exactly the binary numbers matching the following 
      regular expression: \((0 | (1^*)) (00 | 11)^* (0^* | 1)\)

   b) Convert your NFA from part (a) into an equivalent DFA. Draw the equivalent DFA.
c) Minimize your DFA from part (b). Draw the equivalent minimum-state DFA.
4. [45 points]
Is the following context-free grammar in LALR? Provide a proof.

0 \quad S \rightarrow E$
1 \quad E \rightarrow Ex$
2 \quad E \rightarrow 0
Undergraduates stop here. The remaining problem is for graduate students only.

5. [20 points]
Draw a DFA accepting exactly the binary numbers that are multiples of 3, as well as the empty string. Assume that leading zeroes are allowed.