Instructions: Do not put your name on the exam, please answer all the questions directly on the exam itself. You may need scratch paper. Answer all the questions. Explain answers as fully as possible, give examples or define terms, if appropriate.

1. Convert the following NFA over the alphabet \{0, 1\} to a DFA using the subset construction. Note that some edges represent more than one transition. The start state of the NFA is 1; the final states, marked by double lines, are 3 and 4. Be sure to label the states of your DFA with sets of the NFA’s state labels, so that the correspondence is clear. Do not simplify.

![NFA Diagram]

2. What is the relationship between the set of languages recognized by LR(1) parsers and the set of languages recognized by SLR parsers? Circle the best response.
   (a) LR(1) is a proper subset of SLR
   (b) SLR is a subset of LR(1)
   (c) Their intersection is non-empty
   (d) Their intersection is empty
   (e) They are the same set

3. What is the relationship between the set, \(S\), of ambiguous grammars and the set of LL(1) grammars? Circle the best response.
   (a) \(S\) is a proper subset of LL(1)
   (b) LL(1) is a proper subset of \(S\)
   (c) Their intersection is non-empty
   (d) Their intersection is empty
   (e) They are the same set
4. What is the relationship between the set of languages recognized by LR(1) parsers and the set of languages recognized by LL(1) parsers? Circle the best response.

(a) LR(1) is a proper subset of LL(1)
(b) LL(1) is a subset of LR(1)
(c) Their intersection is non-empty
(d) Their intersection is empty
(e) They are the same set

5. What is the relationship between the set of languages recognized by LR(1) parsers and the set of languages recognized by LALR(1) parsers? Circle the best response.

(a) LR(1) is a proper subset of LALR(1)
(b) LALR(1) is a proper subset of LR(1)
(c) Their intersection is non-empty
(d) Their intersection is empty
(e) They are the same set


(a) $S$ is a proper subset of $T$
(b) $T$ is a proper subset of $S$
(c) Their intersection is non-empty
(d) Their intersection is empty
(e) They are the same

7. Use left factoring to transform the following grammar with terminals \{$i, t, e$\}:

\[
0 \quad S \rightarrow iEtSeS$
\]

\[
1 \quad S \rightarrow iEtS$
\]

8. Consider the following grammar (where \{(),+,a\} are terminals):

\[
0 \quad S \rightarrow F$
\]

\[
1 \quad S \rightarrow (S + F)$
\]

\[
2 \quad F \rightarrow a$
\]

(a) Compute nullable, FIRST, and FOLLOW for all the nonterminals of the grammar.
(b) Create the LL(1) parse table.
(c) Is the grammar LL(1)?
9. For the following augmented grammar:

\[
\begin{align*}
0 & \quad S' \rightarrow S$
\end{align*}
\]

\[
\begin{align*}
1 & \quad S \rightarrow V = E \\
2 & \quad S \rightarrow E \\
3 & \quad E \rightarrow V \\
4 & \quad V \rightarrow \text{id} \\
5 & \quad V \rightarrow \ast E
\end{align*}
\]

(a) Give a diagram of the LR(1) states and transitions
(b) Give the LR(1) parsing tables.