Problem 1

[20 points] Appel 2.3(a), 2.5(a), 2.8

Problem 2

[30 points] Consider the following grammar $\mathcal{G}$ for a dialect of English (apparently spoken in Buffalo, NY):

\[
\begin{align*}
S & \rightarrow \ NP \ VP \\
S & \rightarrow \ Imp \\
NP & \rightarrow \ N \\
NP & \rightarrow \ N \ Rel \\
VP & \rightarrow \ V \\
VP & \rightarrow \ V \ NP \\
Imp & \rightarrow \ VP \\
Rel & \rightarrow \ NP \ V \\
N & \rightarrow \ buffalo \\
V & \rightarrow \ buffalo
\end{align*}
\]

It might help you to know the conventions $S$ = “sentence”, $NP$ = “noun phrase”, $VP$ = “verb phrase”, $Imp$ = “imperative”, $Rel$ = “relative clause”, $N$ = “noun”, $V$ = “verb”. You may also examine this excerpt from the The American Heritage\textsuperscript{(19)} Dictionary of the English Language, Fourth Edition:

<table>
<thead>
<tr>
<th>buffalo</th>
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<tbody>
<tr>
<td>n. pl. buffalo or buffaloes or buffaloes</td>
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<tr>
<td>1. (a) Any of several oxlike Old World mammals of the family Bovidae, such as the water buffalo and African buffalo.</td>
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<td>1. (b) The North American bison, Bison bison.</td>
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<tr>
<td>2. The buffalo fish.</td>
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<tr>
<td>tr.v. buffaloed, buffaloing, buffaloes</td>
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<tr>
<td>1. To intimidate, as by a display of confidence or authority: “The board couldn’t buffalo the federal courts as it had the Comptroller” (American Banker).</td>
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<td>2. To deceive; hoodwink: “Too often... job seekers have buffaloed lenders as to their competency and training” (H. Jane Lehmam).</td>
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<tr>
<td>3. To confuse; bewilder.</td>
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</tbody>
</table>
(a) Derive “buffalo buffalo buffalo buffalo buffalo” from the start symbol $S$.

(b) Show that $G$ is not SLR by finding a shift/reduce or reduce/reduce conflict.

(c) Can you find a different grammar that is SLR and that accepts the same language (i.e., the same set of strings) as $G$?

(d) Conversely, suppose we define a new grammar $G'$, almost identical to $G$ except that the rules for $N$ and $V$ are replaced by the following:

\[
N \rightarrow \text{bison} \\
V \rightarrow \text{bewilder}
\]

(Note that $G'$ accepts a different language from $G$, but their parse trees are isomorphic.) Show that $G'$ is SLR by building a conflict-free parsing table. (Hint: you can ask ml-yacc for advice, but don’t follow it blindly. In particular, ml-yacc generates LALR parsers, a larger class than SLR.)

**Problem 3**

[10 points] Appel 10.1