CS210 - Programming Languages  
Homework #3 - Fall 2017

Due on or before Wednesday, September 27 at 1:30 PM

Name ____________________________

1. Start with the grammar G6 from your textbook, repeated here:

\[
\begin{align*}
<\text{exp}> &::= <\text{exp}> + <\text{mulexp}> \mid <\text{mulexp}> \\
<\text{mulexp}> &::= <\text{mulexp}> * <\text{rootexp}> \mid <\text{rootexp}> \\
<\text{rootexp}> &::= ( <\text{exp}> ) \mid a \mid b \mid c
\end{align*}
\]

Please modify the grammar G6 in the following ways:

- Add subtraction and division operators (- and /) with the customary precedence and associativity.
- Then add a left-associative operator % between + and * in precedence.
- Then add a right-associative operator = at lower precedence than any of the other operators.

Please note that you need not show the intermediate grammars produced as a result of each modification specified above; just provide the final grammar that is the result of modifying G6 as specified.

2. Prove that each of the following grammars is ambiguous:

Grammar H2a:

\[
\begin{align*}
<\text{person}> &::= <\text{woman}> \mid <\text{man}> \\
<\text{woman}> &::= \text{wilma} \mid \text{betty} \mid <\text{empty}> \\
<\text{man}> &::= \text{fred} \mid \text{barney} \mid <\text{empty}>
\end{align*}
\]

Grammar H2b:

\[
<\text{S}> ::= <\text{S}> <\text{S}> \mid ( <\text{S}> ) \mid ()
\]