Due: beginning of class, Wednesday, 9/21

1. Using the $G_{int}$ grammar below, develop a leftmost derivation for the integer 67198. How many steps are required for the derivation? In general, how many steps would be required to derive an integer with $d$ digits?

$$Int \rightarrow Digit | Digit \ Int$$
$$Digit \rightarrow 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9$$

2. Use the following BNF grammar to
   (a) develop a leftmost derivation for the Identifier, $R2D2$
   (b) develop a rightmost derivation for the Identifier, $R2D2$.
   (c) Draw a parse tree for the derivation in (a).
   (d) Draw a parse tree for the derivation in (b).

3. Consider the following grammar:

   $$S \rightarrow A \ M$$
   $$M \rightarrow S | \epsilon$$
   $$A \rightarrow a \ E | b \ A \ A$$
   $$E \rightarrow a \ B | b \ A | \epsilon$$
   $$B \rightarrow b \ E | a \ B \ B$$

   (a) Describe the language that the grammar generates.
   (b) Show a parse tree for the string $a \ b \ a \ a$.

   (continued on next page)
4. Using the following grammar:

\[
\begin{align*}
Expr & \rightarrow Term + Expr \mid Term \times Expr \mid Term \\
Term & \rightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9 \mid (Expr)
\end{align*}
\]

draw a parse tree for each of the following and compute the final answer for each expression according to the precedence rules imposed by the grammar:

(a) \(7 + 2 \times 3\)
(b) \(7 \times 2 + 3\)

5. Construct a BNF grammar, \(G_{Cstrings}\), to generate strings in C. Strings in C are delimited by double quotes ("), and may not contain newline characters. They may contain double-quote or backslash characters if and only if those characters are “escaped” by a preceding backslash. You may use the following notation to designate all characters except those listed: \(^{(c1 \mid c2 \mid \ldots)}\).