Question 1

2-5 The language $\{a^n b^n\}$ cannot be defined using regular expressions, since the generation of n b's requires "remembering" the value of n from the time the a's were generated. That is, the regular expression a^*b^* generates the language $\{a^m b^n\}$ in which the number m of a's in the string is not necessarily the same as the number n of b's. A simple BNF grammar for generating the language $\{a^n b^n\}$ is given by the rules:

$S \rightarrow aSa \mid bSb \mid aa \mid bb$

The first two rules add exactly one a or one b at each end of the string at each step in the derivation of the string $a^n b^n$.

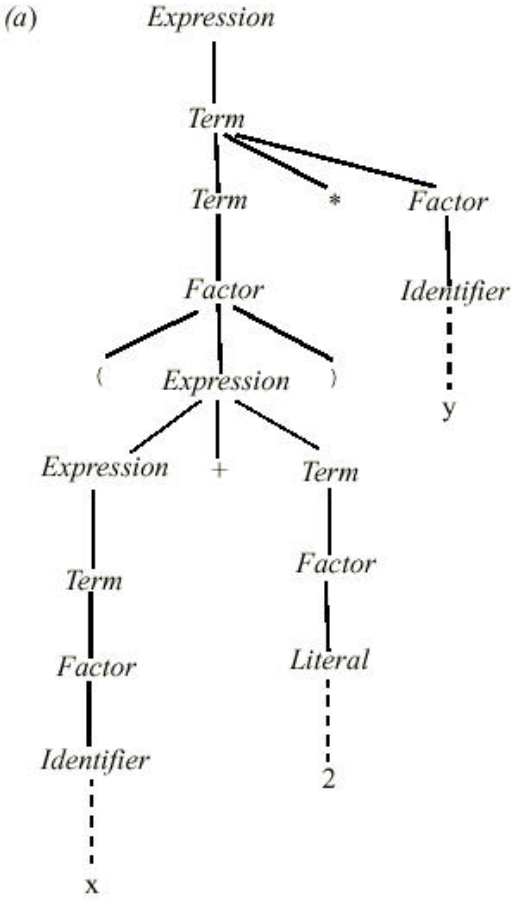
Question 2

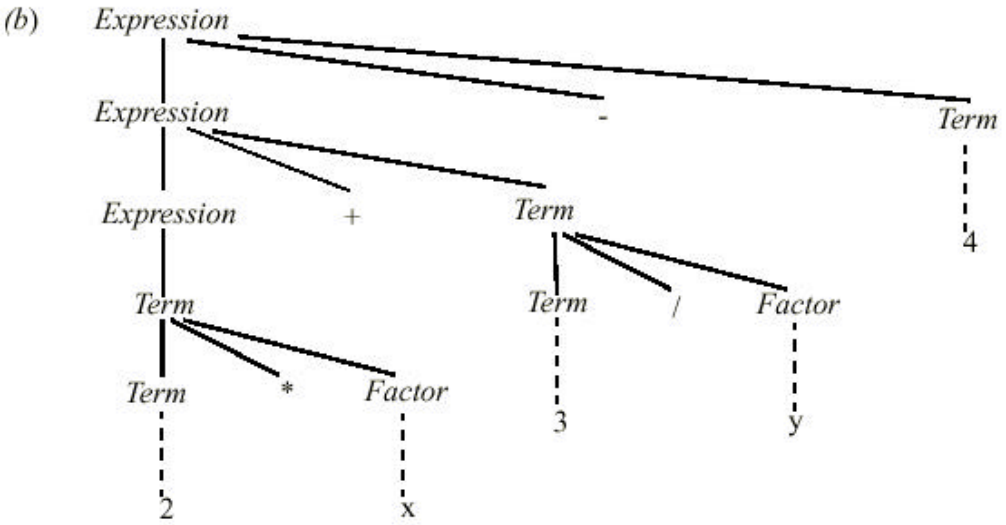
2-6

$$\begin{aligned} Expression &\Rightarrow Expression + Term \Rightarrow Term + Term \Rightarrow Factor + Term \\ &\Rightarrow Identifier + Term \Rightarrow \ldots \Rightarrow \mathrm{x} + Term \Rightarrow \mathrm{x} + Term * Factor \\ &\Rightarrow \mathrm{x} + Factor * Factor \Rightarrow \mathrm{x} + Literal * Factor \Rightarrow \ldots \\ &\Rightarrow \mathrm{x} + 2 * Factor \Rightarrow \mathrm{x} + 2 * Identifier \Rightarrow \ldots \Rightarrow \mathrm{x} + 2 * \mathrm{y} \end{aligned}$$

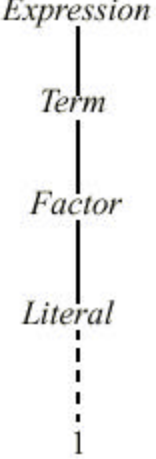
Question 3

2-7 In the following diagrams, dotted lines are used selectively to indicate steps that have been intentionally omitted (to simplify the diagrams).





(c)



Question 4

2-9 To derive the *Expression* 2 - 3 - 4, we must use the rule $Expression \rightarrow Expression - Term$ two times (since that's the only rule that generates the - sign). So the first three steps in the left-most derivation must be:

$Expression \Rightarrow Expression - Term \Rightarrow Expression - Term - Term \Rightarrow Term - Term - Term$

Since no later step in the derivation can reduce the length of this string, each of the three instances of *Term* in the third step must derive one of the constants 2, 3, and 4, respectively.