CS 360 Online Quiz 4

CS 360 Online Quiz Honesty Statement
I am fully aware that once I access quiz problems I am allowed to work with my group partners only 90 minutes on them, that I may use the textbooks, lecture materials, and all other resources available via course website, but neither of the following is permitted: other books or materials, personal notes, web search tools, calculators, contacting other individuals outside my assigned group. By making a submission of my answers to the instructor I acknowledge that I followed the statement of online honesty.

You have 90 minutes for working out quiz problems, and still 15 more minutes for packaging your answers into pdf format and submitting them to the instructor via e-mail.

Solve all three problems. Each problem counts for 3 points. Extra credit problem also counts for three points.

1. Consider the following expression of predicate logic.

$$(\forall X)\left((\forall Y)\left((\forall Z)\left((\exists X)p(X,Y) \text{ AND } (\exists Y)\left(\left(p(X,Y) \text{ OR } q(Y,Z)\right) \text{ AND } r(X)\right)\right)\right)\right)$$

(i) Draw its expression tree and for each bound variable mark the corresponding bounding quantifier.

(ii) Bring it into prenex form. Justify each step of your transformation.

Hint: Follow the examples of figures 1,3 of week 7 file, explained in detail in week 7 lecture on Part 2 material.

2. Explain the principal ingredients of the semantics of the attribute grammar of PLP Figure 4.1. What are semantic rules? Provide illustrating examples to your explanations.

3.

Consider the following CFG for floating-point constants, without exponential notation. (Note that this exercise is somewhat artificial: the language in question is regular, and would be handled by the scanner of a typical compiler.)

$$
\begin{aligned}
&C \longrightarrow \textit{digits}\ .\ \textit{digits}\\
&\textit{digits} \longrightarrow \textit{digit}\ \textit{more\_digits}\\
&\textit{more\_digits} \longrightarrow \textit{digits} \mid \epsilon\\
&\textit{digit} \longrightarrow 0 \mid 1 \mid 2 \mid 3 \mid 4 \mid 5 \mid 6 \mid 7 \mid 8 \mid 9
\end{aligned}
$$

Augment this grammar with attribute rules that will accumulate the value of the constant into a val attribute of the root of the parse tree. Your answer should be S-attributed.

4. (Extra credit) Resolution for Horn clauses has the form

$$\frac{\begin{array}{c} a \leftarrow a_1, a_2, \dots, a_n \\ b \leftarrow b_1, b_2, \dots, b_{i-1}, a, b_{i+1}, \dots, b_m \end{array}}{b \leftarrow b_1, b_2, \dots, b_{i-1}, a_1, a_2, \dots, a_n, b_{i+1}, \dots, b_m}.$$

Resolution presented in FCS has the form

$$\frac{p + q, \bar{p} + r}{q + r}.$$

We have seen in week 7 lecture on Part 2 material that the resolution for Horn clauses implies the FCS resolution. Prove that the inverse is also true, i.e. that the FCS resolution implies the resolution for Horn clauses. We assume that once the FCS resolution is established for logical variables it is also valid after substituting logical variables with logical expressions.
Hint: Use the facts: $p \rightarrow q$ is equivalent to $\bar{p} + q$, $\overline{a_1 a_2 \ \dots a_n}$ is equivalent to $\overline{a_1} + \overline{a_2} + \cdots + \overline{a_n}$, and also apply substitution. Symbols of multiplication and addition denote logical *and* and *or*, the horizontal bar over a logical expression denotes logical *not* applied to it.