CPE 430 Basic Mastery Midterm 2, Spring 2023

Name: _____

- Write down the answers in the space provided.
- You may use all forms that you know from your homework.
- If you need a method and you don't know whether it is provided, define it.
- If a question asks you for "an expression", you may generally supply it either using a concrete syntax or as an AST. When in doubt, use the concrete syntax; it's much easier to write and read (after all, that's why we implement it).
- If a question asks you for an AST, write it in textual form. No pictures, please; they take up a huge amount of space and they're pretty much never precisely correct.
- It's always okay to add helper functions.

Good luck!

Problem 1 Expand the expression '(234 () ()) by writing it using only *cons* and numbers and symbols and '() (and parentheses, of course).

Problem 2 Using one of the AST define-types that we've seen in class or in the book or an assignment, write the AST that corresponds to this VVQS program.

$\{y \ \{\{\} => a\} \ \{\{\} => a\}\}$

Problem 3 Here's an Abstract Syntax Tree for a VVQS4 program, using structures similar to those in the book:

(*list* (*FundefC* 'g '(a b) (*BinopC* '+ (*IdC* 'a) (*AppC* 'b '()))))
    (*FundefC* 'main '() (*AppC* 'g (*list* (*IdC* 'g) (*IdC* 'g)))))))

This AST is expanded from concrete syntax. What is that concrete syntax? Also, write the corresponding program in Python or Java (but if you use Java, leave out the types...).

Problem 4 Here is a program written in VVQS5:

$\{\{\{i\} => \{+ \ 3 \ \{i \ 22\}\}\}$
 $\{\{\{r\} => \{+ \ j \ \{\{\{\} => 4\}\}\}\}$
  where
  $\{[j := 9]\}\}\}$

Assuming an interpreter that uses environments, what variable(s) would the environment contain when evaluating the 4?

Problem 5 Provide definitions for a and b that allow this program to run without error, evaluating to 17, including a call to 'b'.

$\{\{\{\{a\}\ 3\}$ **if** $\{b\}$ **else** $99\}$
  where
  $\{[a := \ ??]$
   $[b := \ ??]\}\}$

Problem 6 Here's a VVQS5 program:

$\{\{\{x\} => \{\{y\} => \{* \ x \ y\}\}\}\ 99\}$

What value does it evaluate to? Write the full value using the structure names that you used in your VVQS5 implementation. You should abbreviate any instances of the top environment as *top-env*.

Problem 7 Suppose we wanted to add a unary *string-length* operator to our VVQS5 language, that accepts a single string and returns its length. Assume for the moment that you're going to add it as its own new kind of expression, not as a more general "unary operator" expression.

- What clause would you have to add to the VVQS5 definition?

- What clause would you have to add to the parser?

- What clause would you have to add to the interpreter, assuming that racket has a *string-length* operator, and that the interpreter takes an expression and an environment?