Programming Languages- Final Exam Spring 2013

Answer 3 of the following 5 questions for 10 points each. 1 extra point for SETE and 2 extra points for ABET evaluations will be added, up to a total of 30, upon proof of submission on Moodle.

Q1. write one Prolog, one Haskell and one Scala program that enumerates all tuples \((x,y,z)\) of natural numbers such that \(x^2+y^2=z^2\), for \(0<x,y,z<10\).

Q2. Using the following Prolog program as an executable specification

```prolog
allWith(X,Xs,Yss):-findall(Ys,insert(X,Xs,Ys),Yss).
insert(X,Xs,[X|Xs]).
insert(X,[Y|Xs],[Y|Ys]):-insert(X,Xs,Ys).
```

write an equivalent Haskell or Scala program.

Q3. Discuss a few advantages and constraints of using parametric polymorphism in a typed language. Give a Scala example and an equivalent Haskell example of a data type declaration that uses it.

Q4. Write a Scala program (possibly using case classes and case objects) equivalent to the following Haskell program:

```haskell
data Nat = Zero | Odd Nat | Even Nat deriving (Eq,Read,Show)

after Zero = Odd Zero
after (Odd n) = Even n
after (Even n) = Odd (after n)

before (Odd Zero) = Zero
before (Odd n) = Even (before n)
before (Even n) = Odd n
```

Test the correctness of your program by checking that, for 3 different values \(n\), it is always the case that

before (after n) == n
after (before n) == n, for \(n \neq Zero\)
Q5. Develop each of the following 2 topics on not more than 1/2 page each.

- **A:** Discuss the advantages and the constraints of the automated memory management that is present in languages like Prolog, Haskell and Scala/Java.

- **B:** Explain the similarities and differences between "mark-and-sweep" and "mark-and-copy" garbage collectors. Assuming that your program creates a large proportion of garbage vs. useful data, which of the two would be more efficient?