**COP 4020 Programming Languages – Fall 2016**

**Midterm Exam on 10/20/2016**

**Instructor: Dr. Pawel Wocjan**

First name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Last name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

PID: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Problem 1: \_\_\_\_ / 10

Problem 2: \_\_\_\_ / 5

Problem 3: \_\_\_\_ / 5

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**Total: \_\_\_\_ / 20**

**Problem 1:**

Each of the 10 subproblems is worth 1 point.

1. Give a short definition of higher-order functions.

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2. Give a short definition of persistence.

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3. Define a polymorphic binary tree using the keyword data.

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4. Evaluate filter (\x -> even x && odd x) [1,2,3,4]

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5. Evaluate zip [1..3] ['a'..'z']

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6. What is the signature of map?

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7. What is the signature of filter?

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8. What is the signature of the partially applied function zip ['a'..'z']?

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9. What is the signature of the function flip, which flips the first input and second input of a general binary function?

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10. Evaluate foldr (++) [] ["Haskell","is","fun!"]

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**Problem 2:**

Implement the function zipWith. You are given its signature to remind you how this function works.

zipWith :: (a -> b -> c) -> [a] -> [b] -> [c]

**Problem 3:**

Implement the function takeWhile and give its **polymorphic** signature. Two examples of how this function works are given below:

takeWhile even [2,4,6,7,10,12] ~~> [2,4,6]

takeWhile odd [2,4,6,7,10,12] ~~> []