CSci 4651 Fall 2008
Problem Set 4: λ-calculus and denotational semantics
Due Wedn., October 1 in class

Problem 1 (10 points). Question 1. For each of the terms show their evaluation in the **call by value** calculus. Continue the evaluation until you either reach the normal form, or, if the term doesn't have a normal form, until you can demonstrate that the term diverges.

1. $(\lambda x.xx)(\lambda y.2+3)$
2. $(\lambda x.x+x)((\lambda y.y)(2+3))$
3. $(\lambda x.\lambda y.x)3$
4. $(\lambda x.xxx)(\lambda x.xx)$
5. $(\lambda z.y)((\lambda x.xxx)(\lambda x.xxx))$

Question 2. For any of the above terms if there is a different evaluation in the call by name calculus, show that evaluation.

Question 3. For all terms above that go into an infinite reduction in the call by value calculus, is there an evaluation in the call by name calculus that stops? If yes, show it.

Problem 2 (2 points). Consider the call-by-name λ-calculus. Given a program

$$(\lambda x.\lambda y.((\lambda z.y)5)x)M,$$

where M is any term, can you replace this program by $(\lambda x.\lambda y.yx)M$ without changing the program's behavior? Why or why not?

Problem 3 (4 points). Exercise 4.8 on p. 85. For question (b) show that the resulting states of the two programs are the same.

Problem 4 (6 points). Calculate the meaning of the following program using denotational semantics.

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x := 5;
y: = 0;
while x > 3 do (y: = y + x; x := x - 2)
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