CS345 Fall 2012 - Homework Assignment # 1

Due Thursday, September 13, 2012 by 5:00 pm. Use turnin to submit your homework (i.e., turnin –submit [MW use swati, TTh use bs2827] cs345_hw1 lambda.pdf)

1. [2 Points] In Section 22 of DeLong (pages 152 – 160), Howard defines multiplication recursively in a manner similar to what was shown in class for addition. Write this definition of multiplication in relation notation and show that 2x3 = 6 using this relation notation. (You can use the Pd function (DeLong, page 158) in your answer if it is useful).

Evaluate (beta-reduce) the λ expressions in problems 2 and 3 in a manner similar to the following example:

```
((λx.λy.(y x) λp.λq.p) λi.i)
(λy.(y λp.λq.p) λi.i)
(λi.i λp.λq.p)
λp.λq.p
```

2. [2 Points] (((λx.λy.λz.((x y) z) λf.λa.(f a)) λi.i) λj.j)

3. [2 Points] (λh.((λa.λf.(f a) h) h) λf.(f f))

4. [2 Points] Use α conversion to ensure unique names in the following expression: λx.λy.(λx.y λy.x)

| X | Y | X *implies* y |
|---|---|---|
| False | False | True |
| False | True | True |
| True | False | False |
| True | True | True |

5. [2 Points] Define a λ calculus representation for *implies*. You should be able to reduce your answer down so that it's in terms of x, and y and maybe true, and/or false. Notice, when X is true, Implies is the same as Y and when X is False, Implies is True.