

## Exercises for Computability and Complexity, Spring 2016, Sheet 5

*Please return your solutions in the Thursday lecture on April 14*

**Exercise 1 (easy).** Show that **and true true = true**. You may use **if true**  $s t \rightarrow^* s$  and **and**  $\equiv \lambda p q. \text{if } p \text{ } q \text{ false}$ .

**Exercise 2 (medium)** Define three  $\lambda$ -terms **a**, **b**, **c** and another  $\lambda$ -term **L** such that **Laa = Lbb = Lcc = Lba = Lca = Lcb = false**, and **Lab = Lac = Lbc = true**. (You may think of **L** as a "properly less than" ordering of **a**, **b**, **c**). Hint: use some of the  $\lambda$ -terms from the lecture notes (Booleans, list operators) in the makeup of **a**, **b**, **c** and **L**.

**Exercise 3 (easy)** Design a  $\lambda$ -expression **LISTSUM**, which applied to a list whose entries are Church numerals returns the sum of the list elements, and returns 0 if the list is empty.