

# CMPT 383 Comparative Programming Languages

## Homework 5

This homework is due by 11:59pm PT on Tuesday Mar 11, 2024. No late submission is accepted. Please save your answers in a single file called `H5_SFUID.pdf` and submit it to Canvas. You may also write on paper and scan it (or take a picture) into a PDF. Please make sure the text is readable.

1. (20 points) Reduce the following  $\lambda$ -term to normal form

$$(\lambda x. x \ y \ x) (\lambda z. z)$$

2. (20 points) Given Church numerals and  $times = \lambda m. \lambda n. \lambda s. \lambda z. m \ (n \ s) \ z$ , show your steps to check

$$times \ 1 \ 2 \rightarrow^* 2$$

3. (20 points) Given the following definition of  $Y$  combinator:

$$Y = \lambda f. (\lambda x. f \ (x \ x)) (\lambda x. f \ (x \ x))$$

Check  $Y \ g = g \ (Y \ g)$  by showing that  $Yg$  and  $g \ (Y \ g)$  reduce to the same  $\lambda$ -term.

4. (20 points) Given the following definitions:

$$\begin{aligned} S &= \lambda f. \lambda g. \lambda x. f \ x \ (g \ x) \\ K &= \lambda x. \lambda y. x \end{aligned}$$

Reduce  $S \ K \ K$  to normal form.

5. (20 points) Define a  $\lambda$ -term called  $or$  such that  $or$  is a binary logical or function for Church booleans. Also, show your steps to check

$$or \ false \ true \rightarrow^* true$$