

# Lecture 11: Operational Equivalence

EN.601.426/626 Principles of Programming Languages – SP26

Name: \_\_\_\_\_

**Informal Definition** (Operational Equivalence): Given two Fb expressions  $e$  and  $e'$ , we say that  $e \cong e'$  if and only if one can be replaced with the other at any place, and no external change in behavior will be observed.

In the following problems, let  $\Omega = (\text{Fun } x \rightarrow x \ x) \ (\text{Fun } x \rightarrow x \ x)$ . Determine whether the given statements are correct.

1.  $2 + 3 \cong 3 + 2$

2.  $\text{Fun } x \rightarrow \text{Fun } y \rightarrow x + y \cong \text{Fun } a \rightarrow \text{Fun } b \rightarrow b + a$

3.  $\text{add} \cong \text{Fun } x \rightarrow \text{add } x$

4.  $\text{Let } \text{Rec } f \ x = f \ (x + 1) \ \text{In } f \ 0 \cong (0 \ 0)$

5.  $\text{Let } o = \Omega \ \text{In } 0 \cong 0$

6. For any  $e$ ,  $\text{If } \text{True} \ \text{Then } e \ \text{Else } \Omega \cong e$

7. For any  $e$ ,  $\text{Let } x = e \ \text{In } x + x \cong e + e$

8.  $\text{Fun } y \rightarrow 0 \cong \text{Fun } y \rightarrow (\text{Fun } x \rightarrow 0) \ \Omega$