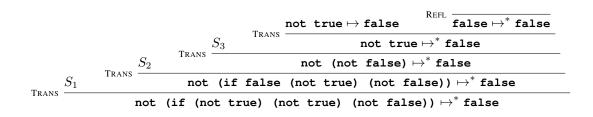
Problem 1a:

$$\frac{\text{NoT-T}}{\text{IF-F}} \frac{\text{true} \Downarrow \text{true}}{\text{not true} \Downarrow \text{false}} \qquad \frac{\text{false} \Downarrow \text{false}}{\text{not false} \Downarrow \text{true}} \\ \frac{\text{IF-F}}{\text{if (not true) (not true) (not false)} \Downarrow \text{true}} \\ \frac{\text{NOT-T}}{\text{not (if (not true) (not true) (not false))} \Downarrow \text{false}}$$

Problem 1b:



$$S_1 = \underbrace{\frac{}{\text{If (not true) (not true) (not false)} \mapsto \text{if false (not true) (not false)}}_{\text{not (if (not true) (not true) (not false))} \mapsto \text{not (if false (not true) (not false))}}$$

$$S_3 = \begin{array}{c} \text{Not } \frac{\text{not false} \mapsto \text{true}}{\text{not (not false)} \mapsto \text{not true}} \end{array}$$

Problem 1c:

Problem 2:

Problem 2:
$$\frac{e \Downarrow \mathtt{false}}{\mathsf{not} \ (\mathtt{if} \ (\mathtt{not} \ e) \ e \ (\mathtt{not} \ e)) \ \Downarrow \mathtt{true}} \qquad \underbrace{\frac{e \Downarrow \mathtt{false}}{\mathsf{not} \ (\mathtt{if} \ (\mathtt{not} \ e) \ e \ (\mathtt{not} \ e)) \ \Downarrow \mathtt{false}}_{\mathsf{Not}.\mathsf{F}} \frac{e \Downarrow \mathtt{false}}{\mathsf{if} \ (\mathtt{not} \ e) \ e \ (\mathtt{not} \ e) \ \Downarrow \mathtt{false}}}{\mathsf{not} \ (\mathtt{if} \ (\mathtt{not} \ e) \ e \ (\mathtt{not} \ e)) \ \Downarrow \mathtt{true}}}$$

Problem 3a:

$$_{ ext{AND-F-L}} rac{e_1 \Downarrow ext{false}}{ ext{and } e_1 \ e_2 \Downarrow ext{false}}$$

$$_{ ext{AND-F-R}} rac{e_2 \Downarrow ext{false}}{ ext{and } e_1 \ e_2 \Downarrow ext{false}}$$

$$-$$
 OR $-$

$$_{ ext{AND-F}} rac{e_1 \Downarrow ext{false}}{ ext{and} \ e_1 \ e_2 \Downarrow ext{false}}$$

Problem 3b:

and true
$$e\mapsto e$$
 and false $e\mapsto$ false

$$_{ ext{AND}} rac{e_1 \mapsto e_1'}{ ext{and } e_1 \ e_2 \mapsto ext{and } e_1' \ e_2}$$