hw1

13. 1. 3.5.12, 3.5.8, 3.5.7
    2. 3.5.12 stays valid with no proof changes, 3.5.7/8 stay valid with no proof changes because they are about reducing something that can't be reduced. 3.5.11 depends on the language itself. The theorem will stay valid if the language is stateless but will have to change the proof. If the language has state then it is no longer valid. The other one is invalid
14. Does not apply for E-PredSucc, E-PredZero, E-IsZeroZero, E-IsZeroSucc since they use values
    E-Succ:
    If $t_1 \to nv$ only one rule applies
    E-Pred:
    If $t_1 \to 0$ only one rule applies
    If $t_1 \to nv$ only one rule applies
    E-IsZero:
    If $t_1 \to 0$ only one rule applies
    If $t_1 \to nv$ only one rule applies
    Therefore by induction hypothesis, if $t_1 \to t_1' \text{ and } t_1 \to t_1''$ then $t_1' == t_1''$
15. Intuition: The two statements agree because lets say that you have a statement `if nat t1 t2`, this would stall because there is no rule to apply to simplify this down (it is in normal form) so it would cause the language to malfunction. Likewise, `if badbool t1 t2` evaluates to wrong (which is also normal form) which gives the user the same info as the language stalling. So in essence, both ways of handling incorrect behavior tell the user the same information by reducing to a normal form so they "agree"
    Proof:

$$\frac{\text{if Nat } t_1\ t_2 \to \text{if Nat } t_1\ t_2}{\text{if badbool } t_1\ t_2 \to \text{wrong}}$$

    Likewise

$$\frac{\text{if badbool } t_1\ t_2 \to \text{wrong}}{\text{if Nat } t_1\ t_2 \to \text{if Nat } t_1\ t_2}$$

    Therefore, the two statements are in agreement
16. WTS: $t \to^* v \iff t \Downarrow v$
    Let this not be true, instead let $t_0 \to^* \text{false } and\ t_0 \Downarrow \text{true}$. Then if we use small step,
    $\text{if } t_1\ t_2\ t_3 \to^* \text{if } false\ t_2\ t_3 \to^* t_3$ and $\text{if } t_1\ t_2\ t_3 \Downarrow \text{if true } t_2\ t_3 \Downarrow t_2$ so

if $t_1\ t_2\ t_3 \Downarrow t_2 \neq \text{if}\ t_1\ t_2\ t_3 \rightarrow^*\ t_3$ which is a contradiction because the same term must evaluate to the same thing therefore the original condition must be true

17. There are a couple changes that need to be made. The original if else rule needs to be deleted (Elf) and this rule needs to be added

$$\frac{t_2 \rightarrow t_2' \quad t_1 \rightarrow t_1' \quad t_0 \rightarrow t_0'}{\text{if}\ t_0\ t_1\ t_2 \rightarrow \text{if}\ t_0'\ t_1'\ t_2'}\text{IfNew}$$

If inference rules are evaluated in order, if not [Redact this part since I just found out that they aren't]

$$\frac{t_2 \rightarrow v_2}{\text{if}\ t_0\ t_1\ t_2 \rightarrow \text{if}\ t_0\ t_1\ v_2} \quad \frac{t_1 \rightarrow v_1}{\text{if}\ t_0\ t_1\ v_2 \rightarrow \text{if}\ t_0\ v_1\ v_2} \quad \frac{t_0 \rightarrow v_0}{\text{if}\ t_0\ v_1\ v_2 \rightarrow \text{if}\ v_0\ v_1\ v_2}$$

Where v_n are values