1

Discuss the pros and cons of call-by-value and call-by-name semantics. [3]

Consider the syntax of the following pure functional language

$$e \quad ::= \quad n \mid \mathbf{fn} \ x{:}T \Rightarrow e \mid e \ e \mid x \mid \Omega$$
$$T \quad ::= \quad \mathsf{int} \mid T \to T$$

where the static and dynamic semantics of Ω are given by rules

(omega) $\dfrac{}{\Gamma \vdash \Omega{:}\mathsf{int}}$ (omega) $\Omega \longrightarrow \Omega$

Give typing rules and CBN dynamic semantic rules for the other constructs. [6]

Give an expression that would behave differently in the CBV and CBN semantics, and give its final state in each (if any). [2]

For this language, the desired type preservation result would be of the form "If $\Gamma \vdash e{:}T$ and $e \longrightarrow e'$ then $\Gamma \vdash e'{:}T$". In proving that, a substitution lemma would be required. Give a statement and proof of that substitution lemma. [9]