## CSE 3302/5307 Programming Language Concepts

Homework 5 - Fall 2025

Due Date: Sep. 22, 2025, 9:00PM Central Time

Name:	UTA ID:
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## Problem1 - 30%

Prove the **exchange lemma**: If  $\Gamma, x: t_1, y: t_2, \Gamma' \vdash e: t$ , then  $\Gamma, y: t_2, x: t_1, \Gamma' \vdash e: t$ . (proof by induction on derivation of  $\Gamma, x: t_1, y: t_2, \Gamma' \vdash e: t$ ).

## Problem2 - 30%

Prove the **weakening lemma**: If  $\Gamma \vdash e : t$  then  $\Gamma, x : t' \vdash e : t$  (provided x not in  $\text{Dom}(\Gamma)$ ). Hint: you may need to use the Exchange lemma.

## Problem3 - 40%

Prove the **substitution lemma**: If  $\Gamma, x: t' \vdash e: t$  and  $\Gamma \vdash v: t'$  then  $\Gamma \vdash e[v/x]: t$ . Hint: you may need to use the Exchange and Weakening lemmas.