

# CSE 3302 Programming Language

Homework 6 - Fall 2026

Due Date: March 2, 2026, 11:59 PM

## Problem 1 - 40%

Given the definition of Fibonacci number

$$F_0 = 0, F_1 = 1, F_i = F_{i-1} + F_{i-2}$$

- (a) Use *fix* to write a lambda function called *fib*: int → int to compute the n-th Fibonacci number.
- (b) We want to extend simple *let* expression to recursive *let rec* expression:

$$\text{letrec } f = \lambda x. e_1 \text{ in } e_2$$

where *f* itself can appear in *e*<sub>1</sub>.

Example usage of *letrec* for factorial:

$$\text{fact} = \lambda n. (\text{letrec fact} = (\lambda i. \text{if } i = 0 \text{ then } 1 \text{ else } i * (\text{fact} (i - 1))) \text{in fact } n)$$

- (1) Define semantic and typing rules for expression *letrec* ;
- (2) Use *letrec* to redefine our Fibonacci function.

## Problem 2 - 30%

Refer to Slides 21. Provide the complete derivation tree of the following expression:

```
let x = 1 in
  let f = \y. y + x in
    let g = (\x. f x) + 1 in
      g (f x)
```

## Problem 3 - 30%

Given the following  $\lambda$  expression:

```
let x = 2 in
  let y = 4 in
    let f1 = \x.\y.x+2*y in
      let f2 = \x.\y.2*x-y in
        f2 (f1 y x) 3
```

Using the environment model for lambda calculus with let,

- (a) Define closures. (Be careful and refer to lecture slides);
- (b) Show detailed multi-step evaluation process of the  $\lambda$  expression above.

**Submission Format:** Submit only the .pdf version of your homework (typed submissions are preferred; Scanned images must be readable). File must be named `lastname_studentID_hw5.pdf`.