

## Homework 4

CS 152 | Spring 2025 | Dr. Sengupta | Naya Singhanian | 017192682

### Question 1

Reduce the following lambda terms

$$\mathbf{a)} \ (\lambda x.(x + y))3$$

$$= [x := 3](x + y)$$

$$= 3 + y$$

$$\mathbf{b)} \ (\lambda x.(\lambda y.yx)(\lambda z.xz))(\lambda y.yy)$$

$$= [x := \lambda y.yy](\lambda y.yx)(\lambda z.xz)$$

$$= (\lambda y.y(\lambda y.yy))(\lambda z.(\lambda y.yy)z)$$

$$= [y := \lambda z.(\lambda y.yy)z](\lambda y.y(\lambda y.yy))$$

$$= (\lambda z.(\lambda y.yy)z)(\lambda y.yy)$$

$$= [z := \lambda y.yy](\lambda z.(\lambda y.yy)z)$$

$$= (\lambda y.yy)(\lambda y.yy)$$

$$= \Omega \text{ combinator (because of the nonterminating recursion)}$$

### Question 2

Prove the following

$$+21 = 3$$

$$+21 = 2 + 1$$

$$+21 = M + N$$

$$+21 = \lambda x.\lambda y.(Mx)((Nx)y)$$

$$+21 = \lambda x.\lambda y.(2x)((1x)y)$$

### Question 3

Use beta reduction to compute the following expression

$$(\lambda x(\lambda x. + (-x1))x3)9$$

$$= (\lambda x(\lambda z. + (-z1))x3)9$$

$$= (\lambda z. + (-z1))93$$

$$= (-91)3$$

$$= +83$$

$$= 3 + 8$$

$$= 11$$

#### **Question 4**

Write a Scheme function named `elements` which counts the number of elements in a list

#### **Question 5**

a)

Write a scheme function that calculates the inner product of two vectors

b)

Implement function `interleave` in scheme, which expects as arguments two lists `xs` and `ys`, and returns a single list obtained by choosing elements alternately, first from `xs` and then from `ys`. When either `xs` or `ys` runs out, `interleave` takes the remaining elements from the other list, so that the elements of the result are exactly the elements of the two argument lists taken together.