CS 357: Declarative Programming
Homework 2

1. Exercises 4.4, 4.6, 4.10, 4.11, 4.18, 4.19, 4.20 from Springer and Friedman.

2. Write a function, *calculator*, which takes an infix arithmetic expression and evaluates it. For example,

```
> (calculator 42)
42
> (calculator '(1 + 2))
3
> (calculator '(1 + (2 * 8)))
17
> (calculator '((((2 + 3) * 2) / 5) + (17 - 1))
18
```

   You may assume that all sub-expressions are parenthesized so that you don't need to worry about precedence. Also, you need only implement the four basic arithmetic functions, namely, plus, minus, times and divide.

3. Write a function, *infix->prefix*, which takes an infix arithmetic expression and returns the corresponding prefix expression.

```
> (infix->prefix 42)
42
> (infix->prefix '(1 + 2))
(+ 1 2)
> (infix->prefix '(1 + (2 * 8)))
(+ 1 (* 2 8))
> (infix->prefix '((((2 + 3) * 2) / 5) + (17 - 1))
(+ (/ (* (+ 2 3) 2) 5) (- 17 1))
```

4. Define a function *iota-iota* that takes an integer *i* as its argument and returns a list of pairs of integers such that

```
> (iota-iota 1)
((1 . 1))
> (iota-iota 2)
((1 . 1) (1 . 2) (2 . 1) (2 .2))
> (iota-iota 3)
((1 . 1) (1 . 2) (1 . 3) (2 . 1) (2 . 2) (2 . 3)
(3 . 1) (3 . 2) (3 . 3))
```

All helper functions should be tail-recursive and should be defined within the body of *iota-iota* using *letrec*.

5. Define a tail-recursive function *digits->number* that takes a list of digits and returns the number represented by those digits. For example,

```
> (digits->number '(7 6 1 5))
7615
```

   Any helper functions you need should be defined within the body of *digits->number* using *letrec*.

6. Write a function, *cond->if*, which takes a *cond* expression, and transforms it into a set of nested if expressions. For example,

```
> (cond->if '(cond ((> x y) (- x y)) ((< x y) (- y x)) (else 0)))
(if (> x y) (- x y) (if (< x y) (- y x) 0))
>
```

7. Write a tail-recursive function, *cos*, which takes a number, x, as its argument and returns $\cos(x)$. Your function should approximate $\cos(x)$ by summing the first 100 terms of the following Taylor series:

$$\cos(x) = \frac{x^0}{0!} - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \frac{x^8}{8!} - \ldots$$

   Any helper functions you need should be defined within the body of *sin* using *letrec*. Note: There is a good way and a bad way to do this. The good way avoids computing the factorial and the power of x which appear in each term in the series from scratch each time. In other words, do not use or define *fact* or *expt*.