Mid-Term Exam 1

CS 3520, Fall 2000   *Edited for Fall 2001*

Name: _____

Instructions: You have one hour and twenty minutes to complete this closed-book, closed-note exam. Please write all answers in the provided space, plus the back of the exam if necessary.

1) Given the following data definition:

$$\langle weed \rangle \quad = \quad \texttt{'leaf}$$
$$| \quad \texttt{(list } \langle weed \rangle \texttt{ 'stem } \langle weed \rangle \texttt{)}$$
$$| \quad \texttt{(list } \langle weed \rangle \texttt{)}$$

Which of the following expressions create examples of ⟨weed⟩?

a) `'leaf`

b) `(list 'stem)`

c) `(list (list 'leaf 'stem 'leaf) 'stem (list 'leaf))`

d) `(list (list (list 'leaf)))`

2) Prove that the following is a ⟨weed⟩:

```
(list (list 'leaf) 'stem (list 'leaf 'stem 'leaf))
```

3) Show a contract and examples for the function `count-leaves`, which takes a ⟨weed⟩ and returns the number of `leaf`s it contains.

4) Implement the function `count-leaves`.

5) Implement the function *grow*, which takes a ⟨weed⟩ and returns a new ⟨weed⟩ that displays like the given one, except that every `'leaf` is replaced by `'(leaf)`.

Be sure to show a contract and examples for your function.

6) Given the following definitions:

```
;; A num-seq is
;;   * (empty-seq), or
;;   * (extended-seq n ns)
;; where n is a number and ns is a num-seq

(define-datatype
 num-seq num-seq?
 (empty-seq)
 (extended-seq (n number?)
               (seq num-seq?)))

(define (F ns)
  (cases num-seq ns
    (empty-seq ()
     0)
    (extended-seq (n old-ns)
     (+ n (F old-ns)))))
```

Provide a suitable contract, purpose statement, and examples for `F`.