CSU211 Exam 1 – Fall 2006

Name:

Student Id (last 4 digits):

Instructor's Name:

High School (State):

- Write down the answers in the space provided.
- You may use the usual primitives and expression forms, including those suggested in hints; for everything else, define it.
- You are *not* required to provide a template unless the problem specifically asks for one. Be prepared, however, to struggle with the development of function bodies if you choose to skip the template step.
- You may obtain a maximum of 55 points: 50 for the first six problems; and five extra-credit points for the final problem.
- We will not answer *any* questions concerning the exam or the 211 material during the exam. Period. Really. Don't bother to ask.

Good luck!

Problem	Points	/out of
1		/ 6
2		/ 6
3		/ 4
4		/ 10
5		/ 11
6		/ 13
Extra		/ 5
Total		/ 55
Base	**50**	

Problem 1 The light from a lightning bolt reaches your eyes almost instantaneously (travelling at the speed of light), but the thunder travels at the much slower rate of 5 miles a second. Thus you can estimate your distance from a lighting strike by counting the seconds between seeing the lighting and hearing the thunder, then dividing by five.

However, your high-school friend, Dwayne (who is now in the honors program at Boston University), has trouble with the math involved in this concept. So you decide to help him out by automating the task.

Design a Scheme function for Dwayne that converts the elapsed time in seconds between lighting and thunder into the distance in miles between you and the strike.

Problem 2 Evaluate the following program step by step and write down next to each step whether it is (1) arithmetic (of any form), (2) function application ("plugging in") or (3) a conditional step.

```
(define (abs x)
  (cond [(< x 0) x]
        [(> x 0) x]
        [else 0]))

(abs (- 10 4))
```

Problem 3 Suppose we are writing software for the embedded processors that control the turnstiles on the T (the Boston subway, that is). During the switchover from tokens to the new "Charlie" stored-value mag-stripe cards, the turnstiles should handle both tokens and Charlie cards. So we use the following data definition to represent payments in either form:

```
(define-struct magstripe-card (value))

;;; A Payment is one of
;;; - 'token
;;; - (make-magstripe-card Number)
```

Develop the template for a function that takes a Payment as its argument.

Problem 4 You spend your summer consulting for a media conglomerate that owns several radio stations. Much of your code manipulates songs and song play-lists that are represented via the following data definition:

```
(define-struct song (artist title year))

;;; A Song is (make-song String String Number)

;;; A List of Songs (LOS) is one of:
;;; - empty
;;; - (cons Song LOS)
```

Your manager needs the function, `oldies`, which takes as its input a list of songs, and returns the list containing all the songs recorded before 1975. Design this function.

Problem 5 A polygon is represented by a list of its vertices, giving us the following data definition:

```
;;; A Polygon is one of
;;; - empty
;;; - (cons Posn Polygon)
```

where `Posn` is as defined in the course textbook. For example, the triangle
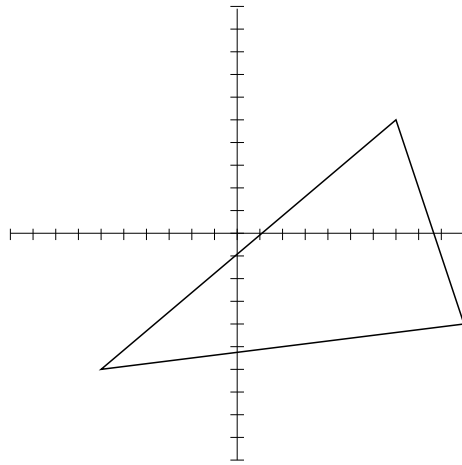
is represented by

```
(cons (make-posn 7 5)
      (cons (make-posn 10 -4)
            (cons (make-posn -6 -6) empty)))
```

Design the function `polygon-first-quadrant?`, which takes a polygon and returns true if it lies entirely in the first quadrant ($x \geq 0$ and $y \geq 0$) of the plane.

Problem 6 Your roommate, Chris, works weekends as a bouncer for a local nightclub, and is responsible for checking ids at the door. Help your roommate out by designing a function to check birth-dates from drivers licenses to ensure that the license holder is over twenty-one.

Suppose we represent a date with the following data definition:

```
(define-struct date (year month day))
```

```
;;; A Date is (make-date Number Number Number)
```

Design a function `(over-21? birthdate today)` that returns true if someone born on date `birthdate` is twenty-one years old or older on date `today`. Hint: First design a function that adds twenty-one years to a date.

Problem 7 (Extra credit) Your crazy instructors have taken on a consulting software development job. They agreed to help some financial company translate their data into a reasonable format. The good news is that they and the managers agreed on a data format:

```
(define-struct single (it rst))
(define-struct intval (low high rst))


      +-------------------------------------+
      |+------------------------------+    |
      ||                              |    |
      vv                              |    |
;; A SON is one of:                   |    |
;; -- 'done                           |    |
;; -- (make-single Number SON)  ----------+    |
;; -- (make-intval Number Number SON) --------+
```

The bad news is that they have never seen such a data definition before and simply don't know how to design a function that adds up all numbers in a SON. Do it for them!

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