

CSU211 Exam 1 – Fall 2007

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.
- The phrase “design this function/program” means that you should apply the design recipe. 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.

Problem	Points	/out of
1		/ 6
2		/ 3
3		/ 13
4		/ 6
5		/ 9
6		/ 13
Extra		/ 5
Total		/ 55
Base	50	

Good luck!

Problem 1 You are working with the Boston Police Dept. on their accounting and benefits systems. One issue that has arisen is computing the number of vacation days granted per year: an employee gets a certain number of vacation days for every year served on the police force. The problem is how to handle the German shepherds that work on the force as police dogs—as is well known, one dog year is equal to seven human years. Thus, a dog who has worked on the force for three years should get 21 human-years of vacation credit.

6 POINTS

Design a Scheme function, `dog-years->human-years`, that takes the number of years a police dog has served on the police force, and converts it to the equivalent number of human years.

Problem 2 Suppose we enter the following text into the Definitions window of Dr.Scheme and click run. What will be output in the Interactions window?

3 POINTS

```
(define-struct planet (name size orbit))
;;; A Planet is (make-planet String Number Number)

(define (double-string s)
  (string-append s s))

(define p1 (make-planet "Venus" 0.95 108000000))
;;; (make-planet "Earth" 1 150000000)
(define p2 (make-planet "Mercury" 0.38 55000000))

(string? (planet? p1))
```

Problem 3 You are hired by the senior zookeeper of the Boston Zoo to write software to help him keep track of his animals. The zoo's collection of animals is represented using the following data definition:

13 POINTS

```
(define-struct animal (name species legs))

;;; An Animal is
;;; (make-animal String Symbol Number)

;;; A List of Animals (LOA) is one of:
;;; - empty
;;; - (cons Animal LOA)
```

Thus, he can track animals such as Mr. Ed, a horse (with four legs), Flipper, a dolphin (with no legs), and Shelob, a tarantula spider (with 8 legs).

The zookeeper needs a function, `count-spiders`, that will take as its input a list of animals, and return the number of spiders in the input list (that is, the number of animals in the list with eight legs). Design this function.

[Here is more space for you to write your answers.]

Problem 4 Let's extend our number system to handle *intervals* using the following data definition:

6 POINTS

```
(define-struct interval (low high))

;;; An Interval is (make-interval Number Number)
;;; and represents the range of numbers
;;; [low,high] = { x | low ≤ x ≤ high }

;;; An Extended Number (XNum) is one of:
;;; - a Number
;;; - an Interval
```

Write the template for a function that takes an XNum as its argument.

Problem 5 You have been hired by some professors at Boston College to implement a sophisticated software system to detect cheating on homework assignments. Your system detects cases where student A (an honest student) does his own work, which is subsequently copied and modified slightly by cheating student B, whose solution is subsequently copied and modified slightly by cheating student C, and so on.

These chains of copying are constructed using the following data definition:

```
(define-struct honest (name solution)) ; Honest student
(define-struct cheater (name stole-from)) ; Cheating student

;;; A CC (cheating chain) is one of:
;;; - (make-honest String String)
;;; - (make-cheater String CC)
```

Thus, if your system detects that lazy student Shivers has copied from honest student Van Horn, it will construct the chain

```
(make-cheater "Shivers"
              (make-honest "Van Horn"
                           "3 * 4 is 12 (I think)."))
```

Write the template for a program that takes a cheating chain as its principal input.

[Here is more space for you to write your answers.]

Problem 6 You are consulting for a DVD rental company. Every movie in the store catalog has a minimum and maximum recommended age, so that the store's web system won't recommend Barney and Teletubbie movies to adult customers, or Quentin Tarantino movies to five-year olds.

13 POINTS

```
(define-struct movie (title min-age max-age))

;;; A Movie is (make-movie String Age Age)
;;; An Age is a number in the range [0,100]
;;; A LOM (list of movies) is one of:
;;; - empty
;;; - (cons Movie LOM)
```

Your manager needs the function `range-select`, which takes as its input a list of movies, and a customer's age (a number), and returns the list containing all the movies appropriate for that customer. Design this function.

[Here is more space for you to write your answers.]

Problem 7 (Extra credit)

5 POINTS

```
;;; A BT (binary tree) is one of:  
;;; - a Number  
;;; - (make-node BT BT)
```

You are consulting for a company that stores numeric data in binary trees. The company needs a program `tree-smallest`, that will take a binary tree and return the smallest number stored in the tree. Design that program.