

CSU2500 Exam 1 – Fall 2010

Name: _____

Student Id (last 4 digits): _____

Section (morning/afternoon/honors): _____

- 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 write $c \rightarrow e$ in place of (check-expect c e) to save time writing.
- Some basic test taking advice: Before you start answering any problems, read *every* problem, so your brain can be thinking about the harder problems in background while you knock off the easy ones.

| Problem | Points | /out of |
|--------------|-----------|---------|
| 1 | | / 5 |
| 2 | | / 4 |
| 3 | | / 7 |
| 4 | | / 12 |
| 5 | | / 12 |
| 6 | | / 15 |
| Extra | | / 5 |
| Total | | / 60 |
| Base | 55 | |

Good luck!

Problem 1 The Computer Science department has noticed what seems to be an exponential increase in the mouse population in WVH. In order to quash a mouse rebellion (they can be unruly), the Dean has agreed to fund a mouse-hunting initiative, code named *Club Mickey Mouse*. As the name suggests, the Dean will select a number of students with excellent hand-eye coordination and issue each student a complimentary club. Each selected student will get a signing bonus of \$80, and will get an additional \$2.50 bounty for each mouse disposed. Before signing off on this venture the department wants to get an estimated cost for the whole effort.

5 POINTS

Design a function, `mickey-cost`, that consumes the number of students hired and the number of mice each student is expected to handle, and calculates the expected total cost in dollars.

Problem 2 A shoe outlet has contacted you to help manage their excessive inventory. The shoes they offer come in three different types. Consider the following data definition they have created to get you started:

4 POINTS

```
;; A ShoeKind is one of:  
;; - 'Walking  
;; - 'Running  
;; - 'Sk8ing
```

What kind of data definition is this?

Write the template for functions that consume a ShoeKind.

Problem 3 Write the step-by-step computation that would be taken if you ran this program in the DrRacket Stepper. For each step, label it as either:

7 POINTS

- **arith:** Primitive “arithmetic” (of any form, not just numeric operations)
- **plug:** Function application—“plugging in”
- **conditional:** A conditional step.

```
(define (prog str) (string-length str))
```

```
(cond [(< (prog "abcdef") 3) (circle 5 "solid" "blue")]  
      [else (* 5 (+ 4 3))])
```

Problem 4 The instructors have decided to hand over the responsibility of calculating the grades for the class to the students. (Power to the people.) Since you love Beginner Student Language, you offer up a great data definition to represent the students in the class and their corresponding grades. Each Student has a name and gets three different grades for the course:

```
;; A Student is:  
;; - (make-student String Number Number Number)  
(define-struct student (name exam1 exam2 hw))  
  
;; Each of the numbers is a percentage from 0 to 100
```

Because we have a lot of students (just look around, but not too closely), you decide to develop a data definition for a list of Students:

```
;; A LoS is one of:  
;; - empty  
;; - (cons Student LoS)
```

Design a function, `top-students`, that consumes a list of Students (LoS) and produces a list containing every student who has scored 90% or better on all three grades.

[Here is some more space for the previous problem.]

Problem 5 Here is a data definition:

12 POINTS

```
;; A Cord is one of:  
;; - (make-us-plug String)  
;; - (make-eu-plug String)  
;; - (make-cable Cord Number)  
  
(define-struct us-plug (where)) ; U.S.  
(define-struct eu-plug (where)) ; European  
;; WHERE field says where the plug is plugged  
;; into the wall (e.g., kitchen, office).  
  
(define-struct cable (next watts))
```

Give three different examples of a Cord.

Write the template for a function that consumes a Cord.

Problem 6 It's no secret that the airline industry is hurting a bit in the recession. A small startup travel company, *PlaneFlying*, thinks they can turn the situation around by developing the right software at the right price.

What is needed is a system to manage customer travel itineraries (plans) and the company truly believes that *one-dimensional travel* is the way of the future. They specifically asked if some of the students in our class might be able to provide a cheap (well, *free*) solution.

Here is the data definition for a travel Plan:

```
;; A Plan is one of:  
;; - 'arrive  
;; - (make-forward Number Plan)  
;; - (make-back Number Plan)  
(define-struct forward (dist plan))  
(define-struct back (dist plan))
```

A travel Plan is either a final destination ('arrive), or it is a forward or backward trip of some distance followed by another Plan.

Design a program, *distance*, that consumes a travel Plan and computes the distance the final destination is from the starting point. That is, a *forward* Plan adds to the distance, and a *back* Plan subtracts from it.

[Here is some more space for the previous problem.]

Problem 7 (Extra credit) Design a program, `to-binary`, that consumes a non-negative integer and converts it to a list of binary digits representing the number in base 2.

5 POINTS

For example, converting 13 would produce the list

```
(cons 1 (cons 1 (cons 0 (cons 1 empty))))
```