

CSU2500 Exam 1 – Fall 2009

Name: _____

Student Id (last 4 digits): _____

Instructor's Name: _____

- 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		/ 6
4		/ 12
5		/ 8
6		/ 15
Extra		/ 5
Total		/ 55
Base	50	

Good luck!

Problem 1 Northeastern University has just won a prestigious National Science Foundation grant for supporting Research Experiences for Undergraduates. The program allows Northeastern to hire a number of students for the summer to hack on research projects like DrScheme. Each student is given a weekly stipend of \$500, plus \$300 for living expenses. An additional overhead amount of 25% of the stipend (not including living expenses) goes toward fringe benefits like health care for the students.

5 POINTS

Design a function, `nsf-fund`, that consumes the number of students Northeastern will employ and the number of months the program will run, and produces the amount of money NSF will have to provide to Northeastern.

Problem 2 Maple syrup comes in several different grades. Consider the following data definition, part of an application that keeps track of a Canadian warehouse's inventory of syrup:

4 POINTS

```
;; A MapleGrade is one of:  
;; - 'AA  
;; - 'A  
;; - 'B
```

What kind of data definition is this?

Write the template for functions that consume a MapleGrade.

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

6 POINTS

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

```
(define (f str) (add1 (string-length str)))
```

```
(cond [false (string-append 1 2)]  
      [else (+ 4 (f "fred"))])
```

Problem 4 You've just landed a job as an Assistant Professor at one of the best research universities in East Cambridge. To please your dean, you've weaseled your way into running one of the top scientific conferences: The Symposium on Improbable Research (SIR). The Symposium accepts a bunch of papers from scientists all over the world and your job is to enlist a bunch of your colleagues to write reviews of the papers and then, based on those reviews, decide which papers will be published and which go in the garbage.

A review is either A, B, C, D, or F. An A is a good paper. An F is, well, not so good. You come up with the following data definition for reviews:

```
;; A Rev is one of: 'A, 'B, 'C, 'D, 'F
```

A paper, which has a title, gets three reviews, so you decide to use the following data definition:

```
(define-struct paper (title rev1 rev2 rev3))  
;; A Paper is a (make-paper String Rev Rev Rev)
```

Because you have a lot of submissions, you decide to develop a data definition for a list of papers:

```
A LoP is one of:  
- empty  
- (cons Paper LoP)
```

Design a function, `good-papers`, that consumes a list of papers and produces all those papers that have at least one "A" review.

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

Problem 5 Here is a data definition:

8 POINTS

```
(define-struct homer (says times))  
(define-struct bart (wants gets))  
;; A Doh is one of:  
;; - (make-bart Symbol Boolean)  
;; - (make-homer Doh Number)
```

Give two different examples of a Doh.

Write the template for a function that consumes a Doh.

Problem 6 As part of major cutbacks in the financial industry, you've been hired to write the software for WellsBanko's accounting system. Every day, people are making withdrawals and deposits to their accounts, which the bank just marks as a pending transaction on their account. At the end of the day, a program goes through the accounts and finalizes all the pending transactions, and computes the new account balances.

Here is the data definition for an account:

```
;; An Acct is one of:  
;; - Number  
;; - (make-dep Number Acct)  
;; - (make-withd Number Acct)  
(define-struct dep (amt acct))  
(define-struct withd (amt acct))
```

An account is either some amount (a number), or it is a transaction of a deposit or withdrawal of some amount on an account. (Recall that a withdrawal *decreases* the balance, a deposit *increases* it.)

Write a program, `balance`, that consumes an account and computes its final balance at the end of the day.

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

Problem 7 (Extra credit)

5 POINTS

```
;; A BT (binary tree) is one of:  
;; - Number  
;; - (make-node BT BT)  
(define-struct node (left right))
```

```
;; A LoN is one of:  
;; - empty  
;; - (cons Number LoN)
```

Design a function `flatten` that consumes a BT and produces a list of all the numbers in the binary tree. Here are some examples:

```
(check-expect (flatten 7) (cons 7 empty))
```

```
(check-expect (flatten (make-node (make-node 3 4)  
                                  (make-node 7 4)))  
              (cons 3 (cons 4 (cons 7 (cons 4))))))
```

```
(check-expect (flatten (make-node 8  
                              (make-node (make-node 2 1)  
                                          7)))  
              (cons 8 (cons 2 (cons 1 (cons 7 empty))))))
```

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