MAKERERE UNIVERSITY
COLLEGE OF COMPUTING & INFORMATION SCIENCES
SCHOOL OF COMPUTING & INFORMATICS TECHNOLOGY
END OF SEMESTER I EXAMINATION 2019/2020

COURSE NAME: Structure and Interpretation of Computer Programs
COURSE CODE: MCN 7105
DATE: 19th November 2019 TIME: 4:00 - 7:00 PM

EXAMINATION INSTRUCTIONS

a) ATTEMPT THREE (03) QUESTIONS
b) ALL QUESTIONS CARRY EQUAL MARKS
c) DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO
d) ATTEMPT EACH QUESTION ~~IN SECTION B~~ ON A NEW PAGE
e) ALL ROUGH WORK SHOULD BE IN YOUR ANSWER BOOKLET

Question 1

A local bookstore, Aristoc, has contacted you to provide an inventory system for their website. We can create a database of books using Scheme. The constructor for a single book will be called **make-book** and takes the name of the book and its price as parameters.

a. Write the constructor make-book and the selectors book-name and book-price. **(6 marks)**

b. The inventory of books will be stored in a list. The selectors for our inventory data structure are first-book and rest-books defined as follows:
$(define first - bookcar)$
$(define rest - bookscdr)$
Write the constructor make-inventory. **(3 marks)**

c. Draw a box-and-pointer diagram that results from the evaluation of **(8 marks)**

```
(define store-inventory
(make-inventory (make-book 'sicp 30000)
(make-book 'software-engineering 25000)
(make-book 'the-little-schemer 15000)))
```

d. Write a procedure find-book which takes the name of the book and inventory as parameters and returns the book's data structure (name and price) if the book is in the store's inventory and nil otherwise. **(3 marks)**

Question 2

Given the following procedure definitions:

```
(define (square x)
(* x x))
(define (sum-of-squares x y)
(+ (square x) (square y)))
(define (f a)
(sum-of-squares (+ a 1) (* a 2)))
```

a. Apply the substitution model of procedure application to evaluate (f 5). **(5 marks)**

b. Use the normal-order evaluation to evaluate (f 5). **(5 marks)**

c. What kind of process is generated by the evaluation of (f 5)? Explain your answer. **(3 marks)**

d. Show the environment structures created by evaluating (f 5). **(7 marks)**

Question 3

What will the Scheme interpreter print in response to the last expression in each of the following sequences of expressions? Also, draw a "box and pointer" diagram for the result of each printed expression. If any expression results in an error, circle the expression that gives the error message. **(5 marks each)**

a.
```
(let ((x (list 1 2 3)))
   (set-cdr! (car x) 4)
   x)
```

b.
```
(let ((x (list 1 2 3)))
   (set-cdr! x 4)
   x)
```

c.
```
(let ((x (list 1 2 3)))
   (set-car! (cdr x) x)
```

```
    x)
```

d.
```
(define a ((lambda (z) (cons z z)) (list 'a)))
    (set-cdr! (car a) '(b))
    a
```

Question 4

A two-dimensional vector v running from the origin to a point can be represented as a pair consisting of an x-coordinate and a y-coordinate.

a. Implement a data abstraction for vectors by giving a constructor make-vector and corresponding selectors xcor-vector and ycor-vector. **(5 marks)**

b. In terms of your selectors and constructor in a) above, implement procedures

   i. add-vector that perform the operations vector addition **(5 marks)**

   ii. *sub-vector* that perform the operations vector subtraction. **(5 marks)**

   iii. *scale-vector* that multiplies a vector by a scalar. **((5 marks)**

GOOD LUCK!