Koç University
College of Engineering

# COMP 301: Programming Language C☺ncepts

Final Examination
Jan 25, 2010, Monday
ENG 208

Instructor: Metin Sezgin
Time Allowed: 120 minutes

**Name:**_____

**Student Number:**_____

**NOTE:** Explain your answers in full. The goal is to demonstrate your understanding of the material, therefore avoid content-free answers. Provide all the work in your exam paper, but make sure the answer boxes have nothing but your final answer to the questions. Include signatures (contracts) for all scheme functions that you define.

I pledge on my honor that I have neither given nor received unauthorized assistance on this exam.

**Signature:**_____

| Question | Worth | Grade |
|---|---|---|
| 1 | 20 | |
| 2 | 10 | |
| 3 | 20 | |
| 4 | 20 | |
| 5 | 10 | |
| 6 | 10 | |
| 7 | 10 | |
| Total | 100 | |

1. (20 points) A multidimensional array can be defined as an array whose elements are either multidimensional arrays or numbers and symbols. For example, the following are all legal multidimensional arrays:

   [MA 3 5 2]
   [MA 3 x 2]
   [MA [MA 3 5 2] [MA 1 1] [MA x y]]

   (a) (10 points) Define the set $S$ which contains all multidimensional arrays in a bottom-up fashion.

   Answer:

   (b) (10 points) Give a grammar-based definition of the set of multidimensional arrays.

   Answer:

2. (10 points) List the benefits of using a lexically addressed language/interpreter as opposed to the simple interpreters we had for LET, PROC etc.

Answer:

3. (20 points) Consider the following piece of program written in IREF:

```
let x=10
    in let f = proc(y) begin set x = -(y,-1); set y = -(y,2)); x end
           in let g = proc(z) -(z,-(0,z))
                  in let t=20
                     in -((g (f t)), t)
```

(a) (4 points) What is the value of the program under call-by-value?

Answer: ☐

(b) (4 points) What is the value of the program under call-by-reference?

Answer: ☐

(c) (4 points) What is the value of the program under call-by-need?

Answer: ☐

(d) (4 points) What is the value of the program under call-by-name?

Answer: ☐

(e) (4 points) In general variants of lazy evaluation may give different results for the same expression. Explain how might happen.

Answer:

4. (20 points) In the class, you have seen what continuations look like for various kinds of expressions. Now, imagine the latest version of our language has been extended with the unary negation (`-`) operation. Write down the continuation for this new expression. Make sure you specify how continuation application works for this expression.

5. (10 points)

You have been handed off two interpreters that explicitly represent continuations. One of the interpreters is trampolined, while the other is not.

(a) (5 points) Draw a diagram which shows the size of the control context in the Y axis, and time on the X axis. On this diagram, draw representative diagrams that show the size of the control context for a typical program using both kinds of interpreters. Carefully label the axes.

Answer:

(b) (5 points) Based on your answer for the first, describe how you would differentiate between the two interpreters.

Answer:

6. (10 points) We have studied many languages so far including LET and PROC. These languages have a variety of ways for introducing declarations.

   (a) (5 points) List at least two ways of introducing declarations.

   Answer:

   (b) (5 points) Write two expressions which essentially perform the same computation, but introduce bindings using the two methods described above.

   Answer:

7. (10 points)

We have enormous amount of code that was written in IREF by a software engineer who thought language used call by value, but now he has found out that the code uses call by reference. Now he wants to write a translator that will convert his code to produce the intended behavior. Describe how the translator should work. In particular describe what needs to be changed and how. Make sure your explanation is not a mere restatement of the task, but includes specific of how the change should occur.