

CSE 304 Final Exam (a)

I. QUESTION

In a language, there is an iteration construct `for`, whose syntax is as follows:

```
for <loop-var> = < expr1 > to < expr2 >
begin
  ...
end
```

<loop-var> is the loop control variable, and < expr₁ > and < expr₂ > denote arithmetic expressions. The loop variable is initialized to < expr₁ >, the loop body is executed, and the loop variable is incremented by 1. The loop terminates when the loop variable exceeds < expr₂ >. Consider the following iteration:

```
for i = a + 1 to b
begin
  ...
end
```

Inside the loop; all the three variables *i*, *a*, and *b* are changed. Write the operational semantics of this iteration if the changes made inside the loop to the loop control variable and the loop parameters

- do not affect the execution of the loop
- affect the execution of the loop.

In both cases, the loop control variable must have the most recently assigned value after loop termination. Define the statements you use for the operational semantics formally.

II. QUESTION

Write a BNF grammar for assignment statements of a programming language which can perform addition (+) and multiplication (*) of operands whose types can only be unsigned binary integers. The language can perform assignments (=) of such expressions to variables. An expression either consists of identifiers or unsigned binary integer constants, or any combination of both that are added or multiplied. There are always two operands on the right hand side of the assignment statements. Identifiers (variable names) contain letters and start with an uppercase letter. Variable names are of arbitrary length and the language is case-sensitive (AB and Ab are different variables). Integer constants can be arbitrarily large and they can be expressed as sequences of binary digits such as 10110, 1111111, 0, etc.

III. QUESTION

Suppose that you are designing a new programming language. For this language, propose a reliable union data type (i.e. show the syntax and explain its semantics). Evaluate this data type in terms of all the design issues relevant to unions.

IV. QUESTION

Consider the following program, which includes a subprogram for calculating factorials. The parameter passing mechanism is pass by value:

```
program main
  decl x
  subprogram fact (n)
    x = ...
    if (n = 1)
      then return (1)
      else return (n * fact (n-1))
    end
  end
  call fact (2)
end
```

Explain the implementation issues (and the compilation issues, when necessary) in every detail, beginning from the start of the execution until the program terminates (i.e. what are the contents of ARIs, how the static and dynamic links are arranged, how the local and nonlocal variables are accessed, etc.), if

- this is a static scoping language
- this is a dynamic scoping language