CARLETON UNIVERSITY

Department of Systems and Computer Engineering

SYSC 3101 **Programming Languages** **Problem Analysis 3**

Wednesday June 13, 2007.

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1. Assume the following program was compiled and executed using static scoping rules. What value of `X` is printed in procedure `Sub1`? Under dynamic scoping rules, what value of `X` us printed in procedure `Sub1`?

```
procedure Main is
    X : Integer;
    procedure Sub1 is
        begin – of Sub1
        Put(X);
        end; – of Sub1
    procedure Sub2 is
        X : Integer;
        begin – of Sub2
        X := 10;
        Sub1;
        end; – of Sub2
    begin – of Main
    X := 5;
    Sub2;
    end; – of Main
```

2. Consider the following program:

```
procedure Main is
    X, Y, Z: Integer;
    procedure Sub1 is
        A, Y, Z: Integer;
        begin – of Sub1
        ...
        end; – of Sub1
    procedure Sub2 is
        A, B, Z: Integer;
        begin – of Sub2
        ...
        end; – of Sub2
    procedure Sub3 is
        A, X, W: Integer;
        begin – of Sub3
        ...
        end; – of Sub3
    begin – of Main
    ...;
    end; – of Main
```

Given the following calling sequences and assuming that **dynamic scoping** is used,what variables are visible during the execution of the last subprogram activated? Include with each visible variable the name of the unit where it is declared.

a) Main calls Sub1; Sub1 calls Sub2; Sub2 calls Sub3;

b) Main calls Sub3; Sub3 calls Sub2; Sub2 calls Sub1;

3. Consider the following program:

```
procedure Main is
    X, Y, Z: Integer;
    procedure Sub1 is
        A, Y, Z: Integer;
        begin – of Sub1
        ...
        end; – of Sub1
    procedure Sub2 is
        A, X, W: Integer;
        procedure Sub3 is
            A, B, Z: Integer;
            begin – of Sub3
            ...
            end; – of Sub3
        begin – of Sub2
        ...
        end; – of Sub2
    begin – of Main
    ...;
    end; – of Main
```

List all of the variables, along with the program units where they are declared, that are visible

in the bodies of Sub1, Sub2, and Sib3, assuming static scoping is used.

4. Multicolumn arrays can be stored in row major order, as in C++, or in column major order, as in Fortran. Develop the access functions for both of these arrangements for three-dimensional arrays.

5. Consider the following C program:

```
int fun( int *i ) {
    i += 5;
    return 4;
}
void main() {
    int x = 3;
    x = x + fun( &x );
}
```

What is the value of `x` after the assignment statement in `main`, assuming:

a) operands are evaluated left to right.

b) operands are evaluated right to left.

6. Assuming the following rules of associativity and precedence for expressions:

Precedence:	*Highest*	$*, /$, **not**
		$+, -$, &, **mod**
		unary $-$
		$=, / =, <, <=, >=, >$
		and
	Lowest	**or**, **xor**
Associativity	left to right	

Show the order of evaluation of the following expressions be parenthesizing all subexpressions and placing a superscript on the right parenthesis to indicate order. For example, for the expression

$$a + b * c + d$$

the order of evaluation would be represented as

$$((a + (b * c)^1)^2 + d)^3$$

a) $a * b - 1 + c$

b) $a > b$ **xor** c **or** $d <= 17$

7. Rewrite the following code segment using a *multiple selection statement* in the following languages:

```
if (k=1) or (k=2) then j := 2 * k - 1;
if (k=3) or (k=5) then j := 3 * k + 1;
if (k=4) then j := 4 * k - 1;
if (k=6) or (k=7) or (k=8) then j := k - 2;
```

(a) C or C++ or Java;

(b) Scheme.