CMSC 330 Practice Exam 2, with answers: Nov. 1999

Show all work necessary to justify your answers!

1. If parameters are passed by value, what will the following program output with:

   - static scoping,
   - dynamic scoping

   for non-local variables.

```
program P;
  var x, y: integer;

  procedure Q;
  begin
    x := y * 4;
  end;

  procedure R;
    var x: integer;
  begin
    x := y + 3;
    y := 2 * y;
    Q;
    writeln(x);
  end;

  x := 2;
  y := 5;
  R;
  writeln(x, y);
end.
```

   static :
   8
   40 10

   dynamic:
   40
   2 10

2. What will the following program output if parameters are passed with:

   - call-by-value
   - call-by-value-result
   - call-by-reference
   - call-by-name (macro expansion)

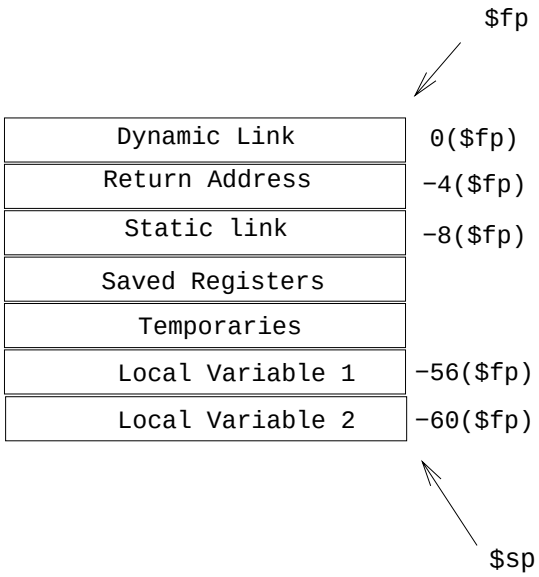
```
program S;
  var x, y, j: integer;

  procedure T (y, z :integer);
  begin
    z := z - 5;
    y := y + 5;
    x := x - y;
  end;
begin
  x := 3;
  y := 4;
  T(x, y);
  writeln (x, y);
end.
```

call-by-value: -5 4
call-by-value-result: 8 -1
call-by-reference: 0 -1
call-by-name: 0 -1

3. This question requires you to write pseudo-code for several MIPS assembly language instructions that must be executed to run the following program. Your pseudo-code should be as detailed as the assembly instructions, but we are not concerned about syntax. For example, the instruction "sw $fp, 0($sp)" can be written as "store the frame pointer at 0 past the stack pointer."

```
program P1;
  var A,B: integer;

  procedure F(N, Total: integer);

    procedure Print(Value: integer);
    begin
      writeln(Value, Total);
    end;

  begin
    if (N >= 1) then
    begin
      Total := Total * N;
      N := N - 1;
      F(N, Total)
    end
    else
      Print(Total)
  end;

begin
  A := 5;
  B := 1;
  F(A, B);
end.
```

You should assume the register and parameter passing conventions discussed in class. The layout of a single stack frame (activation record) is shown below.



(a) Provide the pseudo-code that is necessary to set up the runtime stack when procedure F calls itself recursively, for both the caller and the callee.

In caller:

```
lw $a0, -8($fp)        # static link (same as static link of current
                       # activation of F)
lw $a1, -56($fp)       # get N as first parameter
lw $a2, -60($fp)       # get Total as second parameter
jal F
```

In callee:

```
sw $fp, 0($sp)         # store dynamic link (old frame pointer)
sw $ra, -4($sp)        # save return address (for recursive calls)
sw $a0, -8($sp)        # save static link
sw $a1, -56($sp)       # store parameter N
sw $a2, -60($sp)       # store parameter Total
move $fp, $sp          # set new frame pointer
sub $sp, $sp, 64       # set new stack pointer
```

(b) What does the program print?

120 120