7. (15%) Consider the following Pascal program (with static-scope rule) :

```
1     program test (input, output);
2       var  m : integer;

3       procedure p (function h (n : integer) : integer);
4         begin
5           write(h(2));
6         end;

7       function g (y : integer) : integer;
8         begin
9           g := 5 - y ;
10        end;

11      procedure q;
12        function f (x : integer) : integer;
13          begin
14            p(g);
15            f := m + x;
16          end;
17        begin {q}
18          p(f);
19        end; {q}


20      begin {test}
21        m := 3;
22        q;
23      end. {test}
```

To this program draw the corresponding runtime stack (used for storing activation records) configuration when the function g on line 7 has been called.

8. (15%) Three-address statements refer to the statements with no more than three addresses in which one of the addresses may not be a name. The three-address statement is an abstract form of intermediate code.

(a) List eight types (kinds) of three-address statements that are usually used to represent abstract intermediate code.

(b) Suppose there is a procedure call R(A + B * C, D), where R is a procedure, A, B, C, and D are actual integer parameters of R. Translate this call into corresponding three-address statements.

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Part I. Operating Systems (50%)

1. (15%) Compare the differences between user-level threads and kernel-supported threads. Explain under what circumstances is one type better than the other.

2. (10%) Consistency semantics is an important criterion for evaluation of any file system that supports sharing of files. State the consistency semantics used in Unix file system.

3. (15%) Explain the following interprocess communication mechanism provided by Unix system: pipes, shared memory, and sockets.

4. (10%) What are the possible functions provided by the clock driver in most multitasking operating systems? Suppose there is an operating system in which the clcok driver provides the function - doing program profiling. Explain how to implement it.

Part II. Compilers (50%)

5. (10%) Symbol table is an important data structure used for storing and retrieving information in the process of compilation. State what kinds of information are stored into and/or retrieved from the symbol table during the various phases (lexical analysis, syntax analysis, semantic analysis, intermediate code generation, code optimization, code generation) of a general compiler.

6. (10%) Consider the following grammar

A -> B C

C -> + B C | e

B -> D E

E -> * D E | e

D -> (A) | id

, where A, B, C, D, E are nonterminals, +, *, (,), and id are terminals, and e denotes empty string.

To this grammar write the corresponding recursive procedures for top-down parsing to recognize arithmetic expressions.