Part I. Operating Systems (50%)

1. (10%) Give the definition of "system calls". State that how the operating system handles the system calls involving parameters.

2. (10%) The test-and-set instruction defined below is executed atomically and can be used to solve the critical-section problem. Show how a binary semaphore can be implemented using the test-and-set instruction.

```
function test-and-set (var target:boolean): boolean;
  begin
     test-and-set := target;
     target := true;
  end;
```

3. (10%) There are three major methods of allocating disk space: contiguous, linked, and indexed. State the indexed allocation method. The MS-DOS and OS/2 adopt a simple and efficient method which is actually a variation on the linked allocation approach. Describe that method.

4. (10%) State in UNIX when a file with an absolute path name is opened the handling mechanism conducted by the file system.

5. (10%) Answer the following true or false questions. (You will not be given negative credit for incorrect answers.)

(a) In a multiprocessor system, inhibiting interrupts is insufficient to provide mutual exclusion.

(b) Interrupt service routines usually run in supervisor mode.

(c) The Bakery algorithm provides mutual exclusion for single processor systems but not for multiprocessor systems.

(d) Generally paged systems suffer external fragmentation while segmented systems suffer internal fragmentation.

(e) In terms of interprocess communication, there exist two common models: shared-memory and message-passing. In the shared-memory system, the responsibility for providing communication rests with the operating system; while in the message-passing system, the responsibility for providing communication rests with the application programmers.

Part II. Compilers and Assemblers (50%)

1. (10%) Consider the following BNF grammar G,

$$
\begin{aligned}
S &\rightarrow AC \\
A &\rightarrow aA \mid Bb \mid \epsilon \\
B &\rightarrow bB \mid A \\
C &\rightarrow cC \mid c
\end{aligned}
$$

where S, A, B, and C are nonterminal symbols, a, b, c are terminal symbols and ϵ denotes empty string.

(a) Compute FIRST and FOLLOW for all nonterminals in G.
(b) Is the grammar LL(1)? Why or why not?

2. (10%) Define LR(1) and LL(1) parsing.

3. (10%) State the functions performed by a linking loader (i.e., a linkage and loading system).

4. (10%) For a two-pass assembler, specify separately the tasks conducted at each pass.

5. (10%) Answer the following true or false questions. (You will not be given negative credit for incorrect answers.)

(a) Some LALR grammars are ambiguous.

(b) For a PASCAL program, bounds checking is conducted at compile time.

(c) The LALR parsing table for a grammar has the same size as its LR(0) table.

(d) The FORTRAN syntax can be specified by using a context-free grammar.

(e) The multi-pass compiler generally uses less space but more time than the single-pass compiler to compile a program.