國立臺灣師範大學 114 學年度碩士班招生考試試題

科目：計算機系統　　適用系所：資訊工程學系

注意：1.本試題共 3 頁，請依序在答案卷上作答，並標明題號，不必抄題。2.答案必須寫在指定作答區內，否則依規定扣分。

1. (10 points) Consider the following C function. Assuming all the fork() system calls will succeed, how many processes will be created each time the function `fun` is called? No need to show your derivation.

```
void fun (void) {
    fork();
    if (fork() == 0) {
        fork();
        fork();
    }
}
```

2. (5 points) Use one single sentence to explain the definition of a *zombie process*.

3. (7 points) For the following three statements regarding general OS concepts, pick all the correct statement(s). Points will only be given if all the correct statement(s) were picked.
   (A) It is possible to compile an OS kernel for an architecture other than the one running compilation.
   (B) Every address generated by a user program is a virtual address.
   (C) In a multi-threaded program, all threads share the same address space.

4. (7 points) For the following four statements regarding OS paging, pick all the correct statement(s). Points will only be given if all the correct statement(s) were picked.
   (A) A page fault will occur if the OS cannot perform address translation from the TLB.
   (B) Page table is a per-process data structure.
   (C) Single-level paging may cause more external fragmentations than multi-level paging does.
   (D) None of the above three statements is correct.

5. (7 points) Apply the shortest-job-first OS scheduling policy for the following three jobs. Order the turnaround time starting from the smallest one.
   Job A: arrival time = 0; job length = 30
   Job B: arrival time = 0; job length = 20
   Job C: arrival time = 10; job length = 5
   For example, if the turnaround time of Job X is 20; Y, 10; Z, 25. Then write "Y < X < Z". No need to show your derivation.

6. (7 points) For the following three statements regarding OS file system design, pick all the correct statement(s). Points will only be given if all the correct statement(s) were picked.
   (A) A hard disk may have multiple partitions and each one may run its own file system.
   (B) File descriptors are maintained by the OS on a per-process basis.
   (C) Compared with non-journaling, a journaling file system is relatively fast on crash recovery.

7. (7 points) For the following four statements regarding OS concurrency issues, pick all the correct statement(s). Points will only be given if all the correct statements were picked.
   (A) Semaphore can be used to build a lock.
   (B) A spin lock could cause starvation in an OS running a non-preemptive scheduling policy.
   (C) Deadlock will happen if there is no circular waiting for locks.
   (D) None of the above statements is correct.

8. (10 points) Consider a computer system with a cache of 4K blocks, a four-word block size, a 4-byte word size, and a 32-bit address. For the following cache organization, what are the total number of tag bits?
   (a) (5 points) direct-mapped
   (b) (5 points) four-way set associative

9. (10 points) Examine the following code sequence L1 to L4 in the MIPS five-stage pipeline. Identify all of the data dependencies in the sequence. Let's explore the implications of introducing pipeline stalls in the presence of data hazards (with utilizing forwarding).

   L1: add $3, $4, $2

   L2: sub $5, $3, $1

   L3: lw $6, 200($3)

   L4: add $7, $3, $6

   (a) (5 points) Which dependencies are data hazards that will be resolves with utilizing forwarding?

   (b) (5 points) With utilizing forwarding, which dependencies are data hazards that will cause a stall?

10. (10 points) Amdahl's Law is a formula that identifies potential performance improvements from adding additional computing cores to an application that has both serial and parallel components. If P is the portion of the application that can be executed parallelly on a system with N processing cores, what is the maximum speedup?

11. (10 points) Given the bit pattern 10011011, please answer the following questions to convert it.

   (a) (5 points) If this bit pattern is a two's complement number, what is its decimal representation?

   (b) (5 points) If this bit pattern is an unsigned integer, what is its hexadecimal representation?

12. (10 points) Consider the following MIPS loop. Assume that the register $t1 is initialized to the value 15. What is the final value in register $s2 if $s2 is initially zero?

```
LOOP:   slt    $t2, 0, $t1
        beq    $t2, 0, DONE
        subi   $t1, $t1, 1
        addi   $s2, $s2, 3
        j      LOOP
DONE:
```