

**Important:** This is an open book test; you can use any books, notes, or paper. If there is a syntax error in any program segment, just write it down and you will get full credit for the problem.

1. [6 pt] What are the two main categories of process registers? Give an example of each.
2. [6 pt] What is the difference between SIMD and MIMD? How do they differ from SMP
3. [6 pt] Consider the following code:

```
for ( i = 0; i < 20; i++ )
    for ( j = 0; j < 10; j++ )
        a[i] = a[i] * j;
```

- (a) Give one example of the spatial locality in the code.
  - (b) Give one example of the temporal locality in the code.
4. [6 pt] What is the difference between a monolithic kernel and a microkernel?
  5. [6 pt] A system call changes the process execution mode from user to kernel. How does it achieve that? Why can't I just include an instruction in my code to change the mode from user to kernel?
  6. [6 pt] Including the initial parent process, how many processes are created by the following program?

```
#include <stdio.h>
#include <unistd.h>

int main()
{
    fork();          // Fork a child process
    fork();          // Fork another child process
    if ( fork() )    // And one more
        fork();

    return ( 0 );
}
```

7. [6 pt] What are the steps needed to create a process?

8. [8 pt] Consider two processes  $p_1$  and  $p_2$  that are scheduled by the kernel  $K$ . Indicate which out of the three actors  $p_1$ ,  $p_2$ , and  $K$  causes the following state changes:
- (a) Transition of  $p_1$  from ready to running.
  - (b) Transition of  $p_1$  from running to blocked.
  - (c) Transition of  $p_1$  from running to ready.
  - (d) Transition of  $p_1$  from blocked to ready.
9. [6 pt] What is the difference between *blocking* and *nonblocking* with respect to messages? Give an example of each.