Important: This is an open book test. You can use any books, notes, or paper, but not exchange anything with other students. You are not allowed to use any electronic/communication devices, including a calculator. Do not log into the computer during the test. Switch off your cell phones. Any calculations and rough work can be done on the back side of the test pages. You will lose five points for not writing your name.

1. [6 pt] When discussing the structure of Unix, we say that the shell is at the same level as an application. On the surface, shell seems like just another program that takes a string of data from the user, interprets that string and executes the command. Yet the shell is treated as a special application. What makes the shell so special?

2. [6 pt] Explain the difference between cluster computing and grid computing.
3. [6 pt] Explain the difference between programmed I/O and interrupt-driven I/O. Which out of the two can be used for multiprogramming? Why cannot the other be used for multiprogramming?

4. [6 pt] What is process switching? What is mode switching? Which of the two require intervention by the kernel?
5. [10 pt] Look at the following solution to critical section problem for two processes. Is it a valid solution?

```c
extern bool flag[2];        // Shared flag
extern int turn;            // Shared variable

void process ( const int i )
{
    while ( 1 )
    {
        turn = 1 - i;
        flag[i] = true;
        while ( turn != i && flag[1-i] )
        {
            critical_section();
            flag[i] = false;
            remainder_section();
        }
    }
}
```
6. [6 pt] What is the distinction between blocking and nonblocking with respect to messages?

7. [6 pt] Show that the bakery algorithm adequately solves the critical section problem.