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] Explain how you can change a program while keeping the same process.

2. [6 pt] One of the features to distinguish between `stdout` and `stderr` is that `stderr` is unbuffered while `stdout` is buffered. Can you change `stdout` to be unbuffered? How will you do that?
3. [2+2+5 pt] Consider a memory system with cache memory and main memory. The access time for cache memory ($T_c$) is 100ns while that for main memory ($T_m$) is 1200ns. The cost for cache memory ($C_c$) is 0.01 cents/bit while that for main memory is 0.001 cents/bit.

(a) What is the cost of 1 Mbyte of main memory?
(b) What is the cost of 1 MByte of main memory using cache memory technology?
(c) If the effective access time is 10% greater than the cache access time, what is the hit ratio $H$?

4. [6 pt] What is the difference between an interrupt and a trap? How can you handle multiple interrupts?
5. [10 pt] Consider the following version of bakery algorithm for $n$ processes:

```c
extern int number[n]; // In shared memory

void process ( int i ) // i is process id
{
    while ( 1 )
    {
        number[i] = 1 + max ( number, n );
        for ( int j = 0; j < n; j++ )
            while ( number[j] && ( number[j], j ) < ( number[i], i ) );
        critical_section();
        number[i] = 0;
        remainder_section();
    }
}
```

Does this version violate mutual exclusion? Explain why or why not?
6. [6 pt] The prime motivation of going for higher level synchronization methods (monitors or condition critical regions) is to avoid the mistakes a user may make with the lower level methods (semaphores). Yet, almost all the higher level methods are based on using semaphores. How do you reconcile that?

7. [6 pt] Explain the difference between the wait operation in a semaphore and a condition variable.