90 min, closed book, closed notes exam.

1. **Short answer questions. (20pts)**

   Write between one sentence and a paragraph in response to each of the following.

   (a) The OS uses a process control block (PCB) to maintain the state of a process and a thread control block (TCB) to maintain the state of a thread. What differentiates a PCB from a TCB, and what impact does this difference have on context switching?

   (b) To which type of jobs do scheduling policies for interactive systems give priority and why?

   (c) What is the purpose of synchronization?

   (d) What is the advantages does the atomic instruction "test&set" have over atomic loads and stores?

2. **Processes & Threads. (20pts)**

   Using the *fork()*, *waitpid()*, *exit()* and *kill()* system calls, write a program in which a parent creates a child and the child creates a grandchild. The grandchild prints "I am a grandchild" and sleeps for 60 seconds. The child then kills the grandchild and exits. The parent waits for the child to finish and prints "Child finished" and exits. You may use pseudo-code to write your program.

3. **CPU Scheduling. (20pts)**

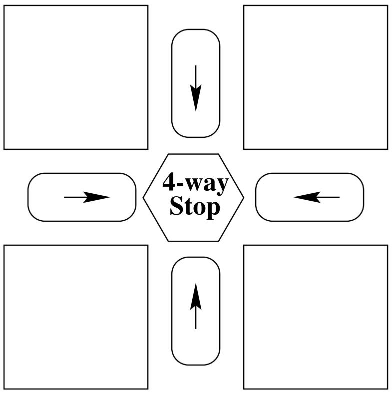
   Consider a variant of Round Robin scheduling in which the usual ready queue (in which PCBs are linked together) is replaced by a queue of pointers to PCBs.

   (a) What is the effect of putting two pointers to a PCB on the queue? (5pts)

   (b) What is one advantage and one disadvantage of this approach? (5pts)

   (c) How could you modify the original Round Robin scheduling algorithm to achieve the same effect without using the queue of pointers? Is your approach better or worse than queues with multiple entries? (10pts)

4. **Synchronization & Deadlock. (40pts)**



Consider this 4-way stop sign, with traffic from all four directions.

(a) Does the rule “yield to the car on the right” prevent deadlock? Why or why not? (10pts)

(b) What is the difference between deadlock and starvation? (5pts)

(c) Instead of the traditional stop sign, you must design an electronic system based on Monitors that allows only one car to enter the intersection at once. Your solution should prevent starvation and deadlock. (25pts)

Below is the code skeleton for one possible solution. You must include the lock-¿Acquire and lock-¿Release in each of your Monitor procedures. d : 0..3 signifies the four directions from which a car can arrive.

```
class IntersectionMonitor {
  public:
    void Arrive&Stop (d: 0..3);
    void Go (d: 0..3);
  private:
    lock = FREE: Monitor Lock;
    atLight[0..3] = False: Condition Variable;
}
Intersection::Arrive&Stop(d: 0..3){

}
Intersection::Go(d: 0..3){{

}
```