Name: _____

1. List those items that comprise the <u>state</u> of a process. (5 points)

2. Explain how a thread differs from a process. (7 points)

3. A complex operating system like UNIX schedules processes at several levels. (14 points)

    a. What does the medium-term scheduler (swapper) do? (3 points)

    b. What does the short-term scheduler (CPU scheduler) do? (3 points)

c. A round-robin CPU scheduler may perform a context switch 100-1000 times a second. What is a context switch, and what does the operating system have to do during one? (4 points)

d. Following up on part (c.) above, why is a context switch performed so often? (2 points)

e. Following up on part (c.) above, why isn't a context switch performed more often? (2 points)

4. Consider this algorithm for mutual exclusion. (7 points)

```
Process 1 {                              Process 2 {
    while true {                             while true {
        while (turn == 1)                        while (turn == 2)
            ; /* do nothing */                       ; /* do nothing */
        critical section                         critical section
        turn = 2;                                turn = 1;
        other non-critical code                  other non-critical code
    }                                        }
}                                        }
```

a. Does it satisfy mutual exclusion? Explain. (2 points)

b. Does it prevent deadlock? Explain. (2 points)

c. What problems does this solution have? (3 points)

5. Consider this implementation of semaphores. (9 points)

```
wait(s):                              signal(s):
    disable interrupts                    disable interrupts
    while (s <= 0)                        s = s + 1;
        ; /* do nothing */
    s = s – 1;
    enable interrupts                     enable interrupts
```

a. What is the purpose of disabling the interrupts? (3 points)

b. What problems are there with disabling the interrupts? (3 points)

c. What problems are there with the "do nothing" loop in wait(s)? (3 points)

6. Most modern operating systems support semaphores, locks, and condition variables. (12 points)

   a. What are semaphores used for? (3 points)

   b. What are locks used for? (2 points)

   c. What are condition variables used for? (2 points)

   d. Briefly describe how semaphores differ from condition variables. (5 points)

7. Describe the shortest-remaining-time (SRT) CPU scheduling algorithm. (7 points)

8. One of the techniques for dealing with deadlock is deadlock avoidance. (9 points)

    a. Briefly describe the Banker's algorithm for deadlock avoidance. (3 points)

    b. What are the advantages of deadlock avoidance over deadlock detection and recovery? (3 points)

    c. What are the disadvantages of deadlock avoidance using the Banker's algorithm? (3 points)

9. Many concepts and algorithms are applicable to more than one problem. For example, the first-fit and best-fit algorithms can be used to place objects into holes. Describe <u>at least two</u> of the three situations discussed in class for which these algorithms can be used in an operating system and how they might be used in each situation. For extra credit, do this for all three situations. (6 points)

10. Demand paging is the most common method of memory management used in modern operating systems. (12 points)

    a. Draw a diagram and explain how virtual addresses are converted into physical addresses using paging. (5 points)

    b. What kind of fragmentation can occur in paging? Explain. (3 points)

    c. What is a page fault, and what must the operating system do when this happens? (4 points)

11. Fill out the following table, listing those items that are stored in each data structure <u>in UNIX</u>. For <u>extra credit</u>, do the same thing for Nachos. (12 points)

Item	UNIX	Nachos (extra credit)
Partition (4 points)		
File descriptor (5 points)		
Directory (3 points)		