Name:

Operating Systems
Fall 2011
Final Exam
December 08, 2011

Closed books, notes, cell phones, PDAs, iPods, laptops, etc. No headphones, please. You may use a simple calculator (but you can do without).

You have 120 minutes to solve 7 problems. You get 10 points for writing your name on the top of this page. As with any exam, you should read through the questions first and start with those that you are most comfortable with. If you believe that you cannot answer a question without making some assumptions, state those assumptions in your answer.

Partial credit will be offered only for meaningful progress towards solving the problems.

Please read and sign below if you agree with the following statement:

In recognition of and in the spirit of the academic code of honor, I certify that I will neither give nor receive unpermitted aid on this exam.

Signature:_____

0	/10
1	/10
2	/10
3	/10
4	/15
5	/15
6	/15
7	/15

Total	/100

1. (10 points) **Short Answer Questions**:
   a) A computer hardware feature that is vital to the effective operation of a multiprogramming operating system is:
      1. Very large memory
      2. Multiple processors
      3. I/O interrupts and DMA
      4. All of the above

Answer: _____

   b) The behavior of an individual process can be characterized by examining:
      1. A single process trace
      2. Multiple process traces
      3. The interleaving of the process traces
      4. All of the above

Answer: _____

   c) The scheduling strategy where each process in the queue is given a certain amount of time, in turn, to execute and then returned to the queue, unless blocked is referred to as:
      1. Prioritization
      2. Round-Robin
      3. LIFO
      4. All of the above

Answer: _____

   d) The processor execution mode that user programs typically execute in is referred to as:
      1. User mode
      2. System mode
      3. Kernel mode
      4. None of the above

Answer: _____

   e) One of the disadvantages of User-Level Threads (ULTs) compared to Kernel-Level Threads (KLTs) is:
      1. Scheduling is application specific
      2. When a ULT executes a system call, all threads in the process are blocked
      3. Thread switching does not require kernel mode privileges
      4. All of the above

Answer: _____

2. (10 points) Explain what is the problem with the following implementation of the reader-writer problem:

```
int readcount;        // shared and initialized to 0
Semaphore mutex, wrt; // shared and initialized to 1;

// Writer:
semWait(wrt);
/* Writing performed*/
semSignal(wrt);


// Readers:
semWait(mutex);
readcount := readcount + 1;
if readcount == 1 then
     semWait(wrt);
semSignal(mutex);
/*reading performed*/
semWait(mutex);
readcount := readcount - 1;
if readcount == 0 then
     semSignal (wrt);
semSignal(mutex);
```

3. (10 points) Suppose the following two processes, foo and bar are executed concurrently and share the semaphore variables S and R (each initialized to 1) and the integer variable x (initialized to 0).

```
void foo() {
do {
     semWait(S);
     semWait(R);
     x++;
     semSignal(S);
     SemSignal(R);
} while (1);
}
```

```
void bar() {
do {
     semWait(R);
     semWait(S);
     x--;
     semSignal(S;
     SemSignal(R);
} while (1);
}
```

   a. Can the concurrent execution of these two processes result in one or both being blocked forever? If yes, give an execution sequence in which one or both are blocked forever.

   b. Can the concurrent execution of these two processes result in the indefinite postponement of one of them? If yes, give an execution sequence in which one is indefinitely postponed.

4. (15 points) Uni-processor Scheduling: Given the following processes, their arrival time, and service time:

Process Name	Arrival time	Processing Time
A	0	1
B	1	9
C	2	1
D	3	9

Draw the execution of the processes from their start to their completion for each of these scheduling policies:

A. First-come, first-serve (FCFS)
B. Round Robin, q =1
C. Round Robin, q = 4
D. Shorter Process Next (SPN)
E. Shorter Remaining Time (SRT)

Use "X" to indicate when a process is in execution.

A) First-come, first-serve (FCFS)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																					
B																					
C																					
D																					

B) Round Robin, q =1

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																					
B																					
C																					
D																					

C) Round Robin, q = 4

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																					
B																					
C																					
D																					

D) Shorter Process Next (SPN)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																					
B																					
C																					
D																					

E) Shorter Remaining Time (SRT)

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
A																					
B																					
C																					
D																					

5. (15 points) Given the following state for the Banker's Algorithm:
   6 processes P0 through P5
   4 resource types: A (15 instances); B (6 instances); C (9 instances); D (10 instances)

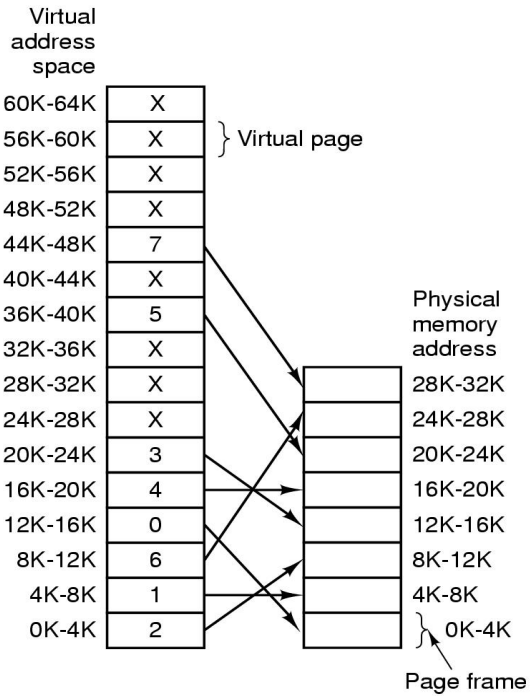
   Snapshot at time T0:
   Available

A	B	C	D
6	3	5	4

	Current allocation				Maximum demand			
Process	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
P0	2	0	2	1	9	5	5	5
P1	0	1	1	1	2	2	3	3
P2	4	1	0	2	7	5	4	4
P3	1	0	0	1	3	3	3	2
P4	1	1	0	0	5	2	2	1
P5	1	0	1	1	4	4	4	4

   a. Show that the current state is safe. In addition, show how the Available array changes as each process terminates.
   b. Given the request (3, 2, 3, 3) from Process P5, should this request be granted? Why or why not?

6. (15 points) Using the page mapping below, answer the following questions:
    a. How many bits are used for an address in the virtual address space? How many bits for page number and how many for offset?
    b. Give the physical address corresponding to each of the following virtual addresses or explain what prevents you from answering this question (in terms of memory management events, state, and/or actions to be taken next):
        i) 47800
        ii) 33400



7. (15 points) Assume you are given a uniprocessor system with one gigabyte of memory and a 300 gigabyte disk. The OS on the machine has a demand paged virtual memory system with a local page replacement policy and a multi-level feedback queue (MLFQ) CPU scheduler. On the system there are two compute-intensive jobs running: Job-A and Job-B. Job-A has a working set* of 50 gigabytes while Job-B has a working set of 100 megabytes. Assume you left the system to run for a while until it reached a steady state with both jobs running.
    c. Which job would you expect to have a higher CPU scheduling priority from the MLFQ scheduler?
    d. Assume you add a second CPU to system, how would this affect the priorities of the jobs?
    e. Assume you switch from a local to a global page replacement policy, how does this change affect the priorities of the jobs?

    Justify your answer and state any assumptions you make.

    *Think of the working set as the memory footprint. That is, how much memory is seen as consumed by the process when, for example, you run the top command in a Unix terminal or use the Task Manager on a Windows machine.