Operating Systems Comprehensive Exam

Spring 2012

Student ID # _____

2/23/2012

You must complete all of Section I

You must complete two of the problems in Section II

If you need more space to answer a question, use the back of a page and indicate which question is being answered.

Section I: You must complete all problems in this section.

1. When it is not known at compile time where a process will reside in memory, _____ code must be generated.

logical **relocatable** **physical** **absolute** **relative**

2. Allows I/O devices to transfer data directly into main memory without passing it through the CPU.

base registers **page table** **DMA** **threads** **none of these**

3. **Matching:** for each state transition below, **list** all events, programs or actions in the column on the right that could cause the specified state transition to occur.

a) _____ A process moves from ready to running

b) _____ A process moves from waiting to ready

c) _____ A process moves from running to waiting

A. CPU scheduler
B. I/O system call
C. Job scheduler
D. I/O completion
E. timer interrupt
F. the process exits

4. Which of the following scheduling algorithms can potentially result in process starvation?

First-Come, First-Served **Shortest Job Next** **Round Robin** **none of these**

5. The _____ bit attached to each entry in a process's page table indicates that the page is loaded into the process' logical address space.

dirty **mode** **valid/invalid** **write** **read**

6. Which multithreading model requires that a new kernel thread be created for each new user thread?

many-to-one **one-to-one** **many-to-many** **none of these is correct**

7. To reduce the number of entries in a file allocation table, file blocks are grouped into _____.

buffers **virtual memory** **clusters** **fragments**

8. Memory compaction can be used to minimize the effects of _____ fragmentation.

internal **external** **both** **none of these**

9. A file handle (or file descriptor) is a pointer into the _____.

open file table **file control block** **directory** **file allocation table**

10. If a system is in an unsafe state, it is guaranteed that a deadlock will occur. **True** **False**

Briefly explain your choice, i.e., why is your answer correct?

11. **Briefly explain** what occurs when the UNIX *fork()* system call is executed. Describe how the calling process can be distinguished from the resulting child process and also how the child process can load and execute new code.

12. Internal fragmentation can occur when using (circle all that apply):

linked file allocation	**contiguous memory allocation**	**memory paging**
memory segmentation	**contiguous file allocation**	**indexed file allocation**

13. External fragmentation can occur when using (circle all that apply):

linked file allocation	**contiguous memory allocation**	**memory paging**
memory segmentation	**contiguous file allocation**	**indexed file allocation**

14. **List** the four necessary conditions for a deadlock:

15. **List** the three requirements that must be satisfied to implement a valid critical section:

16. a) **Explain** the error in the following pair of *Semaphore* operations and suggest a change that would make it work correctly (assume that S is initially 0)?

```
wait(S)  {
   while(S > 0);
   S--;
}
```

```
signal(S)  {
   S++;
}
```

b) Assume that you have access to a correctly implemented version of the above *Semaphore*. **Briefly explain** two disadvantages of using this type of Semaphore to control access to a critical section.

Section II: You must complete `two` of the following three problems (A, B, C). If you complete more than two problems, clearly indicate which two problems you want graded. Otherwise, only the first two attempted problems will be graded.

A. Consider the following list of disk access requests, in arrival order. For each disk scheduling algorithm, calculate the number of tracks that the read/write head crosses without stopping. The disk drive has 200 tracks, from 0 to 199, and the read/write head has a starting location of track **100**.

Show your work to receive partial credit, otherwise an incorrect answer will get zero points.

54, 112, 36, 93, 86, 126, 22, 41, 151

(a) First-Come, First-Served _____

(b) Shortest Seek Time First _____

Consider a paging system with the page table stored in memory.

(a) If a memory reference takes 10 microseconds, what is the effective memory access time (with no TLB)?

_____ microseconds

(b) We add a TLB where the time needed to find a page reference in the TLB is 5 microseconds. If the TLB contains 80% of the page references (assume that all TLB misses are still in memory), what is the effective memory access time?

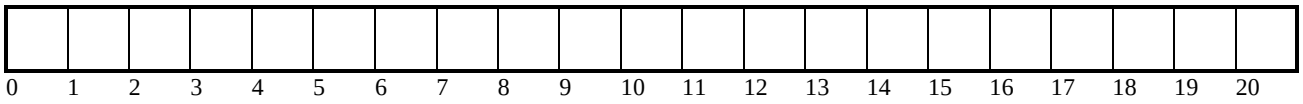
_____ microseconds

B. Given the following set of processes, answer the questions below. Assume that each new process arrives after the interrupted process has been returned to the ready queue. If two processes arrive at the same time, or have the same remaining burst time, schedule them in process number order.

Process Id	Burst Time	Arrival Time
1	6	0
2	4	1
3	2	2
4	4	4

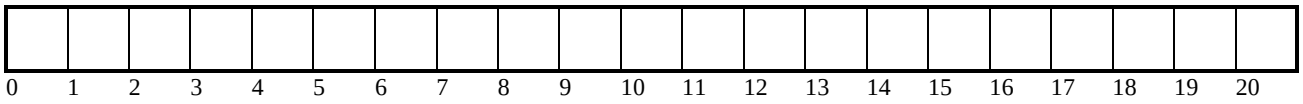
Fill in the following Gantt charts as specified and answer the questions associated with each part. Write the process number of the executing process in the cell for each time unit.

1) First-Come-First-Served (non-preemptive):



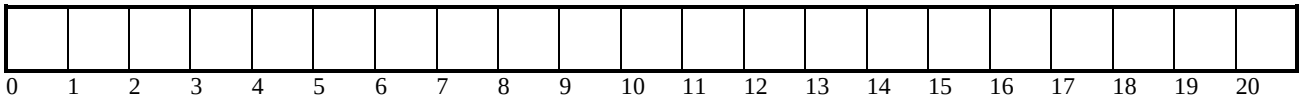
Average waiting time = **What was the turnaround time for process 2 _____**

2) Shortest-job-first (preemptive):



Average waiting time = **Which process had the longest response time _____**

3) Round Robin (time slice (quantum) is 1 time unit):



Average waiting time = **What was the turnaround time for process 2 _____**

C. 1) Describe Belady's anomaly for page replacement.

2) Given the following list of page references, in execution order:

```
1, 2, 3, 4, 2, 1, 5, 3, 1, 2, 4, 5
```

Trace the LRU page replacement algorithm with only 4 frames available for pages (All pages are initially empty.) You must **show your work** to receive full credit.