MCS-378 Intraterm Exam 2

This exam is closed-book and mostly closed-notes. You may, however, use a single 8 1/2 by 11 sheet of paper with *hand-written* notes for reference. (Both sides of the sheet are OK.)

Please write your name only on this page. Do not turn the page until instructed, in order that everyone may have the same time. Then, be sure to look at all problems before deciding which one to do first. Some problems are easier than others, so plan your time accordingly. **You have 50 minutes to work.**
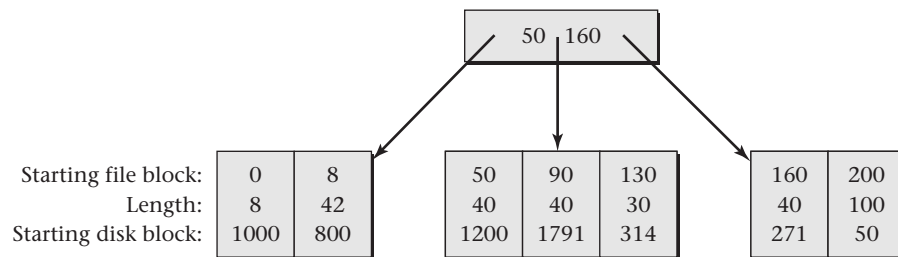
Write the answer to each problem on the page on which that problem appears. You may also request additional paper, which should be labeled with your test number and the problem number.

Printed name: _____

Problem	Page	Possible	Score
1	2	20	
2	3	20	
3	4	20	
4	5	20	
5	6	20	
Total		100	

1. [**20 Points**]

(a) Assume an inode contains 12 direct block numbers, as well as single, double, and triple indirect block numbers. Further, assume that each block is 4 KB, and that each block number is 8 bytes. What is the largest a file can be? (You may give your answer as a formula that could be used to calculate the answer; you don't need to do the arithmetic. Keep in mind that K means 1024 in this context, not 1000.)

(b) Starting with the situation shown in the B^+-tree extent map below, a defragmentation program replaces the first two extents with a single extent starting at block 2000 on disk. Assume the particular kind of B^+ tree being used requires leaf nodes to have either two or three extent descriptors. Show how the tree would be modified.

		50 ⸳160		

Starting file block:	0	8		50	90	130		160	200
Length:	8	42		40	40	30		40	100
Starting disk block:	1000	800		1200	1791	314		271	50

2. [**20 Points**]   Give at least two situations in which COW is used and explain in each case why
it is valuable. Your explanations should be specific to each of the situations you list; do not just
give one generic explanation of what makes COW valuable. (If you don't know what the acronym
"COW" stands for, I can translate its letters into words for you, at a cost of one point per letter
you choose to have me translate.)

3. [**20 Points**]

    (a) In disk space allocation, what is the difference between internal fragmentation and external fragmentation? What causes each?

    (b) If the size of a file system's disk blocks is increased, will internal fragmentation increase or decrease? Why?

    (c) If the size of a file system's disk blocks is increased, will external fragmentation increase or decrease? Why?

4. [**20 Points**]

   (a) Modern POSIX systems (such as Linux and Mac OS X) support multi-threading within each process, so that it isn't necessary to `fork` a child process in order to achieve concurrency within an application program. However, `fork` is still heavily used. What for?

   (b) When used in this way, after `fork` succeeds in creating a child process, that child process will typically almost immediately execute another system call. Which procedure, or family of closely related procedures, from the POSIX API is executed by the child?

   (c) Which procedure, or family of closely related procedures, from the POSIX API is typically executed by the parent at some point after it has called `fork`? (I am looking for something related to the `fork`; there are plenty of unrelated API procedures the parent might well call.)

5. [**20 Points**] On a POSIX system (such as Linux or Mac OS X), a file with name `/foo/bar` has wide open permissions (`rwxrwxrwx`), but the directory `/foo` has much more restrictive permissions, `rwxr-x---`. The directory is owned by user 32 and group 49. List five different ways in which it could happen that a program run by user 87 modifies the contents of the file, despite the restrictive permissions on the directory. (Do not consider such complete evasions of the protection system as stealing user 32's password or exploiting a bug in the system.)