Name, SURNAME and ID ⇒

Middle East Technical University
Department of Computer Engineering

CENG 334

Section 1 and 2
Spring ’2009-2010

Final

- **Duration: 120** minutes.
- **Exam:**
  - This is a **closed book**, **closed notes** exam. No attempts of cheating will be tolerated. In case such attempts are observed, the students who took part in the act will be prosecuted. The legal code states that students who are found guilty of cheating shall be expelled from the university for **a minimum of one semester**!
- **About the exam questions:**
  - The points assigned for each question are shown in parenthesis next to the question.
  - Whereever available, use the boxes to write down your answers.
- **This booklet consists of *8* pages including this page. Check that you have them all!**
- **GOOD LUCK !**

Question 1	
Question 2	
Question 3	
Question 4	
Question 5	
Total ⇒	

1 (21 pts)

Consider the the Readers-Writers problem, where a certain data structure is being read and written (modified) by concurrent threads. While the data structure is being written, it is necessary to stop other threads from reading, in order to prevent a reader from interrupting a modification in progress and reading inconsistent or invalid data.

The synchronization constraints are:

- Any number of readers can be in the critical section simultaneously.
- Writers must have exclusive access to the critical section.

In other words, a writer cannot enter the critical section while any other thread (reader or writer) is there, and while the writer is there, no other thread may enter. When a writer exits the critical section, it can wake up either a waiting reader or a waiting writer.

Write synchronization code for readers and writers that enforces these constraints using semaphores. The readers would execute `read();` and the writers would execute `write();` when they get access to the critical sections. Note that the `read();` and `write();` calls will be made in the middle of the reader and write functions and that your synchronization code would surround them. You can declare and initialize semaphores as `sem = semaphore(1);` and use them by calling two methods as `sem.up();` or `sem.down();`. Note that although a number of declarations are provided for you, you are free to declare and use more as necessary. Write your code in the skeletons provided on the next page.

Hint: Think of the critical section as an auditorium that can be used by either students (readers) or janitors (writers) who do the cleaning. You can imagine that the auditorium has a ”student lightswitch” that is turned on by the first student who gets in the auditorium, and turned off by the last student who leaves the auditorium. The light would block the janitors to get in. Similarly there is a ”janitor lightswitch” that blocks the entrance of other students and janitors.

```
int nReaders = 0;
semReaders =  semaphore(1);  // semaphore for readers

semWriters =  semaphore(1);    // semaphore for writers

void reader(){




















}
void writer(){




















}
```

2 (09 pts)

Disk requests that are queued in the disk driver for cylinders are: 15, 22, 12, 2, 40, and 8. The disk head is currently positioned over cylinder 20. A seek takes 5 milliseconds per cylinder moved . What is the sequence of reads and total seek time using each of the following algorithms?

- Shortest Seek Time First.
- SCAN (initially moving upwards).
- CSCAN (initially moving upwards).

3 (20 pts)

Consider a machine with a virtual memory architecture with the following parameters:

- Virtual addresses are 48 bits.
- The page size is 32K byte.
- The architecture allows a maximum 64 Terabytes (TB) of real memory (RAM).
- The first- and second-level page tables are stored in physical memory.
- All page tables can start only on a page boundary.
- Each second-level page table fits exactly in a single page frame.
- There are only valid bits and no other extra permission, or dirty bits.

Draw and label a figure showing how a virtual address gets mapped into a real address. You should list how the various fields of each address are interpreted, including the size in bits of each field, the maximum possible number of entries each table holds, and the maximum possible size in bytes for each table (in bytes). Also, your answer should indicate where checks are made for faults (e.g., invalid addresses).

This page is left blank for your answer.

4 (20 pts)

Consider the following virtual page reference string :

0, 1, 2, 3, 0, 1, 4, 0, 1, 2, 2, 4, 5

How many page faults would occur for the following replacement algorithms, assuming that there are three page frames in the machine? Show your work using the templates below (i.e., show what page goes in what frame and mark where a page fault occurs)! Assume that none of the process's pages are loaded in memory when the above trace starts.

(a) FIFO

Access	0	1	2	3	0	1	4	0	1	2	2	4	5
Frame 1	0	0	0										
Frame 2		1	1										
Frame 3			2										
Fault?	X	X	X										

Number of faults:

(b) OPT (Optimum page replacement)

Access	0	1	2	3	0	1	4	0	1	2	2	4	5
Frame 1	0	0	0										
Frame 2		1	1										
Frame 3			2										
Fault?	X	X	X										

Number of faults:

(c) LRU (least recently used)

Access	0	1	2	3	0	1	4	0	1	2	2	4	5
Frame 1	0	0	0										
Frame 2		1	1										
Frame 3			2										
Fault?	X	X	X										

Number of faults:

(c) Clock (or Second Chance) algorithm. Assume that the hand is initially pointing to Frame 1 and that the Reference bits of all frames are cleared at every four accesses as marked by double vertical lines (||) in the table. Mark the position of the hand in the table.

Access	0	1	2	3	0	1	4	0	1	2	2	4	5
Frame 1	0	0	0										
Frame 2		1	1										
Frame 3			2										
Fault?	X	X	X										

Number of faults:

5 (30 pts)

- (4 pt) In an MS-DOS FAT file system on a disk containing 2^s sectors with sector size of 2^d-bytes, what would be the size of the FAT table, and what would be the largest file that can be stored in the filesystem in bytes?

- (4 pt) A UNIX filesystem has V-byte blocks and d-byte disk addresses. What is the maximum file size if i-nodes contain n direct entries, one single, one double and one triple indirect entry each?

- (10 pt) In a UNIX filesystem write down the sequence of disk operations are needed to remove the file **/fb/2010/championship.mov**. Assume that only the inode of the root directory is in the memory, each directory consists of a single block and that the championship.mov file contains only 1 data block (since it didn't last much ;).

- (2 pt) Briefly state the difference between a hard link and a soft link.

- (2 pt) Briefly explain what copy-on-write is (with respect to the virtual memory system) and give at least one instance when it might be useful.

- (2 pt) What's the main difference between a port and a bus?

- (2 pt) Briefly explain the difference between deadlock and starvation.

- (2 pt) Briefly explain what double buffering is in I/O systems.

- (2 pt) What's the difference between type 1 and type 2 hypervisors in virtualization.