Dept. Computer Science	**Operating Systems**
Vrije Universiteit	**21.03.2011**

1a What are the purposes of an operating system? *5pt*

1b Modern CPUs typically offer a privileged (kernel) and a unprivileged (user) execution mode. For what reason? Give an example of an instruction that should be only available in privileged mode. What parts of Minix and Linux run in privileged/unprivileged mode? *5pt*

2a What are the states a process can have and what are the possible transitions from one state to another? *5pt*

2b What are the prerequisites for avoiding race conditions? *5pt*

2c Sketch out how you could implement counting semaphores using the `cli()` (disable interrupts) and `sti()` (enable interrupts) instruction of an x86 CPU. What problems do you see with such an implementation? *10pt*

2d The following table shows five processes, their arrival times and the time required to complete their execution. Explain the order of execution for each of the following scheduling algorithms: (1) First-Come-First-Served (FCFS), (2) Shortest Job First (without preemption), (3) Shortest Remaining Time Next, and (4) Round Robin (with preemption and quantum equal to 2). *5pt*

Process	Arrival Time	Execution Time
A	3	4
B	2	2
C	4	5
D	1	1
E	0	4

3a What is DMA? Please describe how it is used by device drivers. What would be an alternative to using DMA? *10pt*

3b What are the differences between character and block device files? Give examples devices for both kinds (at least 2 for each). *5pt*

4a How is fork system call implemented in Minix 3? *5pt*

4b Name three different different page replacement strategies. Compare and contrast the strategies. *10pt*

4c What is the function of a TLB in x86? How does it work? *5pt*

5a In a university using a UNIX operating system, the grades of students are kept in a file named `grades.dat`. Teachers use a program called `set_grade` to modify the grades. Students may use the program `get_grade` to view their only own grade. The teachers belong to the user group *teachers* and the students belong to the user group *students*. How would you set the permissions and ownership of the executables and the grade database to force the requirements mentioned above? *5pt*

5b What is the theoretical maximum file size of a file system using the following i-node format and a 512 byte blocksize? Each entry of the i-node consists of 4 byte and blocks are addressed using 32 bit addresses.

Mode
Number of Links
UID
GID
Access Time
File Size
Modification Time
Access time
Zone 1
Zone 2
Zone 3
Zone 4
Indirect Zone
Double Indirect Zone

5pt

6 Have a look at the source code sample below. Where do you think this code sample is taken from (i.e. What part of Minix)? When might this function be called? Also please describe in detail, what you think this code sample is doing. Please justify your answer by referring to the source code. *10pt*

```
01  PUBLIC int function_name(dev)
02  Dev_t dev;
03  {
04    register struct inode *rip;
05    struct super_block *sp, *sp1;
06    int count;
07    count = 0;
08    for (rip = &inode[0]; rip< &inode[NR_INODES]; rip++)
09          if (rip->i_count > 0 && rip->i_dev == dev) count += rip->i_count;
10    if (count > 1) return(EBUSY);
11
12    sp = NIL_SUPER;
13    for (sp1 = &super_block[0]; sp1 < &super_block[NR_SUPERS]; sp1++) {
14          if (sp1->s_dev == dev) {
15                  sp = sp1;
16                  break;
17          }
18    }
19
20    (void) do_sync();
21    invalidate(dev);
22    if (sp == NIL_SUPER) {
23          return(EINVAL);
24    }
25
26    dev_close(dev);
27
28    sp->s_imount->i_mount = NO_MOUNT;
29    put_inode(sp->s_imount);
30    put_inode(sp->s_isup);
31    sp->s_imount = NIL_INODE;
32    sp->s_dev = NO_DEV;
33    return(OK);
34  }
```

Grading: *The final grade is calculated by adding the scores per question (maximum: 90 points), and adding 10 bonus points. The maximum total is therefore 100 points. The curve will be adjusted if the exam is too difficult.*