Department of Computer Science	**Operating Systems**
VU University Amsterdam	**02.07.2015**

This exam consists of two pages. No calculator, pencil, or open books allowed. Concise answers!

1 The client-server model is popular in distributed systems. Can it also be used in a single-computer system? *6pt*

2 In which three situations is the execution transferred from a user process to the operating system kernel? *6pt*

3 After issuing a CTRL+C sequence, the active shell program dumps some debug output and keeps running. What happened? *8pt*

4 A soft real-time system has four periodic events with periods of 50, 100, 200, and 250 msec each. Suppose that the four events require 35, 20, 10, and x msec of CPU time, respectively. What is the largest value of x for which the system is schedulable? *6pt*

5 Explain what the Test-Set-Lock instruction (TSL) does and show how it can be used to protect a critical region. *6pt*

6 Some POSIX Threads API implementations support *adaptive* user-level mutexes, which first try to acquire a mutex by spinning on a lock variable and, only after a predetermined number of unsuccessful attempts, resort to a *normal* user-level mutex implementation. What is the purpose of this extra complexity? Why are *adaptive* mutexes only supported on multi-processor systems? *8pt*

7 Consider the banker's algorithm in the figure below. The three vectors at the right of the figure show the existing resources, E, the possessed resources, P, and the available resources, A, respectively. Assume that processes A and D change their requests to an additional (1, 2, 1, 0) and (1, 2, 1, 0) respectively. Can these requests be met and the system still remain in a safe state? *6pt*

Process	Tape drives	Plotters	Printers	CD ROMs
A	3	0	1	1
B	0	1	0	0
C	1	1	1	0
D	1	1	0	1
E	0	0	0	0

Resources assigned

Process	Tape drives	Plotters	Printers	CD ROMs
A	1	1	0	0
B	0	1	1	2
C	3	1	0	0
D	0	0	1	0
E	2	1	1	0

Resources still needed

E = (6342)
P = (5322)
A = (1020)

8 Describe the steps a device driver needs to perform to write a block of data to the disk. *6pt*

9 Does memory-mapped I/O consume any virtual and/or physical memory? Explain. *8pt*

10 When segmentation and paging are both being used, as in Intel x86, first the segment descriptor must be looked up, then the page descriptor. Does the TLB also work this way, with two levels of lookup? *6pt*

11 What is the purpose of the following code? What does each instruction do?

```
1  push ecx
2  push edx
3  push eax
4  call _main
5  push eax
6  call _exit
7  hlt
```

6pt

12 What is the difference between *CLOCK* and the *Second Chance* page replacement algorithm? *8pt*

13 What is the difference between a hard link and a symbolic link? Give an advantage of each one. *6pt*

14 What are the factors limiting the maximum file size in UNIX-like file systems? *6pt*

15 You are given a program reading a single byte from a file in a UNIX-like file system (with inodes using up to triple indirect blocks). You profile the I/O disk operations performed during the execution of the program and observe the following results on 3 different systems: (i) 5 reads and 1 write; (ii) 5 reads and 0 writes; (iii) 0 reads and 0 writes. Explain the nature of such disk operations and the that of the differences observed on the 3 systems. *8pt*