

COMP30640 Operating Systems
Semester 1

Name: _____

In-class test

07/11/2017

Time Limit: 50 Minutes

Student number _____

This exam contains 4 pages (including this cover page) and 9 questions.
Total of points is 100.

No document permitted. Use of Calculators prohibited.

Grade Table (for teacher use only)

Question	Marks	Score
1	5	
2	5	
3	10	
4	10	
5	10	
6	10	
7	10	
8	15	
9	25	
Total:	100	

1. (5 marks) Which of the following are correct? An Operating System is: (**multiple answers**)
 - ☐ **A piece of software**
 - ☐ A piece of hardware shipped with your computer
 - ☐ **A program running at all times on the computer**
 - ☐ A graphical user interface
2. (5 marks) Which of the following statements are not true? (**multiple answers**)
 - ☐ **The operating system kernel consists of all system and application programs in a computer.**
 - ☐ A system call is triggered by applications.
 - ☐ There is no universally accepted definition of an operating system.
 - ☐ **System calls can be run in either user mode or kernel mode.**
3. (10 marks) What is the defining characteristic of a monolithic operating system? Why do monolithic operating systems tend to be efficient?
Every component of the operating system is contained in the kernel. Tight integration: few calls cross from user space to kernel space.
4. (10 marks) Why is memory protection important in an operating system? What is the main memory protection mechanism?
OS and user processes exist in the same physical memory: Some mechanism must protect the kernel (primary) memory from being accessed by user processes (and also the memory allocated to a process from being accessed by other processes) Simplest scheme is to use base and bound registers: these registers are loaded by the OS before starting the execution of any program in user mode: $\text{base} \leq \text{address} < \text{base} + \text{bound}$; otherwise exception raised.
5. (10 marks) Define in your own words the following concepts: program, process, thread.
Program passive entity stored on disk (executable file)
Process one instance of a program in execution. Program becomes process when executable file loaded into memory. At any time, there may be more than one process running a different instance of the same program
Thread defines a single sequential execution stream within a process
6. (10 marks) What is a Process Control Block (PCB)?
Process Control Block is a structure in the operating system representing a process (1 per process). It contains: process ID, process state, process privileges, registers/program counters, memory information, I/O information (list of open files, list of open inter process communication channels), pointers to other data structures, accounting information.

7. (10 marks) Processes can be in several states, namely: ready, waiting, and running. For each of these states, discuss how a process might get into that state, and what the process is waiting for (if anything).

- **New:** The process has just been born and will be admitted to the ready queue as soon as it is fully set up.
- **Ready:** The process is waiting to run, i.e., to get access to CPU (which is decided by the Scheduler).
- **Running:** Instructions are being executed (the process has access to the CPU).
- **Waiting:** Process waiting for some event to occur. After the event happens the process will be ready and will join the ready queue. For instance the process can be waiting for an I/O query to be processed, or for a timer to end, etc.
- **Terminated:** The process has finished execution and will be removed from memory.

8. (15 marks) Discuss Dijkstra's conditions for a true solution to the problem of synchronisation on a critical section (i.e., list the conditions and explain what they mean).

Dijkstra identified 3 conditions:

- **Mutual exclusion:** one process at most inside the CS at any time
- **Progress**
 - A process in execution out of a CS cannot prevent other processes from entering it
 - If several processes are attempting to enter a CS simultaneously the decision on which one goes in cannot be indefinitely postponed
 - A process may not remain in its CS indefinitely (neither terminate inside it)
- **Bounded waiting (no starvation):** A process attempting to enter its CS will eventually do so

9. (25 marks) A system has the following resources: R1, R2, R3 and R4 and processes P1, P2, P3, P4, P4. The total available resources are:

R1	R2	R3	R4
5	2	4	3

The processes have the following maximum requirements and current allocations:

Process	Current Allocation				Maximum Allocation			
	R1	R2	R3	R4	R1	R2	R3	R4
P1	2	0	1	1	3	1	1	1
P2	0	1	0	0	0	2	1	2
P3	1	0	1	1	4	1	1	1
P4	1	1	0	1	1	1	1	1

Is the system in a safe state (as defined by the Banker's algorithm)? If yes, show a non blocking sequence of process executions. Otherwise, provide a proof that the system is unsafe. Show all steps, intermediate matrices, etc.

The currently available resources are:

R1	R2	R3	R4
1	0	2	0

The processes have the following needs and current allocations:

Process	Current Allocation				Needs			
	R1	R2	R3	R4	R1	R2	R3	R4
P1	2	0	1	1	1	1	0	0
P2	0	1	0	0	0	1	1	2
P3	1	0	1	1	3	1	0	0
P4	1	1	0	1	0	0	1	0

Only P4 can be granted resources (available resources are greater than P4 needs. Then P1. Then either P2 or P3. The processes have the following needs and current allocations:

Process	Current Allocation				Needs				Available before			
	R1	R2	R3	R4	R1	R2	R3	R4	R1	R2	R3	R4
P4	1	1	0	1	0	0	1	0	1	0	2	0
P1	2	0	1	1	1	1	0	0	2	1	2	1
P2	0	1	0	0	0	1	1	2	4	1	3	2
P3	1	0	1	1	3	1	0	0	4	2	3	2