COMP30640 Operating Systems **Name:** _____
Semester 1

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In-class test
26/10/2018
Time Limit: 50 Minutes Student number _____

This exam contains 4 pages (including this cover page) and 7 questions.
Total of points is 100.

No document permitted. Use of Calculators prohibited.

Grade Table (for teacher use only)

Question	Marks	Score
1	20	
2	14	
3	10	
4	10	
5	10	
6	20	
7	16	
Total:	100	

1. (20 marks) List the **five** OS structures that we have discussed in this module and describe in your own words their characteristics.

   - **Simple architecture: Only one or two levels of code. written to provide the most functionality in the least space; Not divided into modules: its interfaces and levels of functionality are not well separated**
   - **Monolithic architecture: every OS component is contained in the kernel and any component can directly communicate with any other (by means of direct function calls). This architecture tends to be highly efficient for this reason.**
   - **Layered architecture: Improves on monolithic kernel designs by adding structure: components are grouped into layers that perform similar functions; Each built on top of lower layers; Bottom layer (layer 0) is hardware; Highest layer (layer N) is the user interface. Advantages: modularity imposes structure and consistency (easier validation, debugging, modification, reuse). Problems with layered architectures: Appropriate definition of layers is difficult; a layer is implemented using only those operations provided by lower-lever layers; a real system structure is often more complex than the strict hierarchy required by layering; performance issues: processes' requests might pass through many layers before completion (layer crossing) + system throughput can be lower than in monolithic kernels**
   - **Microkernel architecture: Minimises the services offered by the kernel, in an attempt to keep it small and scalable: Small core OS running at kernel level; OS Services built from many independent user-level processe; No consensus about minimal set of services inside micro- kernel (at least: minimal process and memory management capabilities, plus inter-process communications); Services such as networking and file system tend to run non-privileged at the user process level (i.e. out of the micro-kernel). Communication takes place between user modules using message passing. Benefits: easier to extend a microkernel; easier to port the operating system to new architectures; more reliable (less code is running in kernel mode); more secure. Drawbacks: performance overhead of user space to kernel space communication**
   - **Modular architecture: Many modern operating systems implement loadable kernel modules: Uses object-oriented approach; Each core component is separate; Each talks to the others over known interfaces; Each is loadable as needed within the kernel; Overall, similar to layers but with more flexible (e.g., Linux, Solaris).**

2. Let's consider two OS structures: monolithic kernel and microkernel. Which of these types better satisfies the following requirements? Justify your answers.

   (a) (7 marks) Convenient access to operating system components and data. **Monolithic – access from any part of the kernel to any other part is possible.**

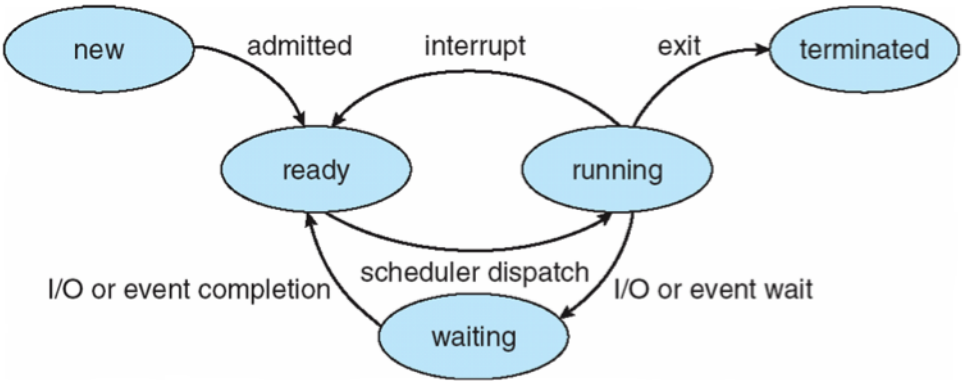

Figure 1: Caption

With a microkernel access is via message passing.

(b) (7 marks) Addition of new operating system components. **Microkernel – no (or little) modification is required in the kernel the new service is in user space.**

3. (10 marks) What is the purpose of system calls? **System calls allow user-level processes to request services of the operating system.**

4. (10 marks) Describe the CPU protection mechanism **We must ensure that the OS always maintains control: a user program might get stuck into an infinite loop and never return control to the OS. Timer: Generates an interrupt after a fixed or variable amount of execution time; OS may choose to treat the interrupt as a fatal error (and stop program execution) or allocate more execution time.**

5. (10 marks) Define process control block (PCB) in your own words and give 4 of its fields. **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**

6. (20 marks) Draw the diagram showing the life-cycle of a process and explain what the states and transitions represent. **Figure 1 describes the life-cycle of a process**

7. The semaphore wait and signal operations are defined as atomic (indivisible) operations.

   (a) (8 marks) Why do they have to be atomic? **If they weren't atomic it would be possible for multiple waits and signals to occur simultaneously (on a multiprocessor) or at least interleaved with each other. This would corrupt the value of the semaphore and prevent it working properly.**

   (b) (8 marks) Because they are atomic does that mean that all other processes running on a multiprocessor system must stop when a wait or signal operation is executed?

Explain why or why not. **No. Strictly only processes accessing the same semaphore at that time need to stop. Any processes not wanting to change or access the semaphore should be allowed to continue.**