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※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

1. Describe the actions taken by a kernel to context-switch between processes. (10%)
2. In designing and implementing an operating system, one important principle is the separation of policy from mechanism. Please describe the reasons from the point view of flexibility and resource allocation. (10%)
3. CPU scheduling deals with the problem of deciding which of the processes in the ready queue is to be allocated the CPU. Please describe five different CPU-scheduling algorithms. (10%)
4. Race conditions are possible in many computer systems. Consider a banking system with the following two functions: deposit(amount) and withdraw(amount). These two functions are passed the amount that is to be deposited or withdrawn from a bank account. Assume a shared bank account exists between a husband and wife and concurrently the husband calls the withdraw() function and the wife calls deposit(). Describe how a race condition is possible and what might be done to prevent the race condition from occurring. (10%)
5. (a) Explain the basic method for implementing paging. (5%)  
(b) How are illegal page addresses recognized and trapped by the operating system? (5%)

Choose the correct answers for the following multiple choice problems. Each question may have more than one answer. 10 points each, no partial point, no penalty.

6. Which of the following statements is (are) not true for virtual memory system?
  - (a) It is typically unknown that when a page in memory will be replaced on flash memory or disk.
  - (b) The flash memory is a volatile device and it can be used to store pages in memory.
  - (c) The operating system usually creates the space on flash memory or disk for all the pages of a process when it creates the process.
  - (d) A program can be invoked by the operating system into different instances of processes.
  - (e) The space on the disk or flash memory reserved for the full physical memory space of a process is called swap space.

7. Which of the following statements is (are) true for virtualization technology?
- (a) On a conventional platform, a single operating system owns all the hardware resources, but with a virtual machine (VM), multiple OSes all share the hardware resources.
  - (b) The software that supports VMs is called a virtual machine monitor (VMM) or hypervisor which determines how to map the virtual resources to the physical resources. A physical resource may be time-shared, partitioned, or even emulated in software.
  - (c) The cost of processor virtualization depends on the workload. User-level processor-bound programs often have great virtualization overhead.
  - (d) I/O-intensive workloads are generally also OS-intensive, executing many system calls and privileged instructions that can result in high virtualization overheads.
  - (e) If the I/O intensive workload is also I/O bound, the cost of processor virtualization can be completely hidden, since the processor is often idle waiting for I/O.
8. Which of the following is (are) true for the control hazards in a pipelined processor?
- (a) Control hazard comes from a data cache miss.
  - (b) Considering two instructions  $i$  and  $j$ , with  $i$  occurring before  $j$ ,  $j$  tries to read a source before  $i$  writes it, so  $j$  incorrectly gets the old value. This causes a control hazard.
  - (c) Considering two instructions  $i$  and  $j$ , with  $i$  occurring before  $j$ ,  $j$  tries to read a source before  $i$  writes it, so  $j$  incorrectly gets the old value. This also causes a control hazard.
  - (d) A control hazard arises from the need to make a decision based on the result of a branch instruction while others are executing.
  - (e) When the proper instruction cannot execute in the proper pipeline clock cycle because the instruction was fetched is not the one that is needed.
9. Which of the following is (are) true about program performance?
- (a) The efficiency of a compiler affects both instruction count and average cycles per instruction.
  - (b) The algorithm determines the number of source program instructions executed and thus affects the instruction count. The algorithm also affects the clock rate.
  - (c) The programming language affects the instructions count since the statements in the language are translated into the processor instructions.
  - (d) The instruction set architecture affects the instruction count, clock rate, and CPI.
  - (e) The cache memory and DRAM used both affect the CPI.

10. Which of the following is (are) true about cache operations?

- (a) When a data cache write hit occurs, the written data are also updated in the next level of memory. This is the write-through policy.
- (b) When a data cache write miss occurs, the cache controller first fetches the missing block into cache and then the data are written into the cache. This is the write-allocate policy.
- (c) When a data cache write miss occurs, the cache controller first fetches the missing block into cache and then the data are written into the cache. This is the write-around policy.
- (d) When a data cache write hit occurs, the data are only written into the cache. This is the write-back policy.
- (e) A processor writes data into a cache line which is also present in other processor's cache. This is the write-allocate policy.