1. (20pt)

(1) In multithreaded programs, the kernel informs an application about certain events using a procedure known as a(n) ____.
A) signal
B) upcall
C) event handler
D) pool

(2) In Pthreads, a parent uses the pthread_join() function to wait for its child thread to complete. What is the equivalent function in Win32?
A) win32_join()
B) wait()
C) WaitForSingleObject()
D) join()

(3) A process that has terminated, but whose parent has not yet called wait(), is known as a _____ process.
A) zombie
B) orphan
C) terminated
D) init

(4) Which of the following is true of cooperative scheduling?
A) It requires a timer.
B) A process keeps the CPU until it releases the CPU either by terminating or by switching to the waiting state.
C) It incurs a cost associated with access to shared data.
D) A process switches from the running state to the ready state when an interrupt occurs.

(5) Which of the following scheduling algorithms must be non-preemptive?
A) SJF
B) RR
C) FCFS
D) priority algorithms

(6) A race condition ____.
A) results when several threads try to access the same data concurrently
B) results when several threads try to access and modify the same data concurrently
C) will result only if the outcome of execution does not depend on the order in which instructions are executed
D) None of the above

(7) Which of the following statements is true?
A) A counting semaphore can never be used as a binary semaphore.
B) A binary semaphore can never be used as a counting semaphore.
C) Spinlocks can be used to prevent busy waiting in the implementation of semaphore.

D) Counting semaphores can be used to control access to a resource with a finite number of instances.

(8) Which of the following statements is true?
A) A safe state is a deadlocked state.
B) A safe state may lead to a deadlocked state.
C) An unsafe state is necessarily, and by definition, always a deadlocked state.
D) An unsafe state may lead to a deadlocked state.

(9) In a dynamically linked library, ____.
A) loading is postponed until execution time
B) system language libraries are treated like any other object module
C) more disk space is used than in a statically linked library
D) a stub is included in the image for each library-routine reference

(10) Suppose we have the following page accesses: 1 2 3 4 2 3 4 1 2 1 1 3 1 4 and that there are three frames within our system. Using the LRU replacement algorithm, what is the number of page faults for the given reference string?
A) 14
B) 13
C) 8
D) 10

2. (5pt) Describe one technique that can enable multiple disks to be used to improve data transfer rate.

3. (10pt) Give an algorithm to solve the "bounded buffer" problem.

4. (15pt) Compare the read/write performance of RAID 4 with RAID 5 in detail.

5. (5pt) Please explain the reason why the single-cycle implementation is rarely used to implement any instruction set of a processer.

6. (5pt) If we want to design a carry-select adder to compute the addition of two 8-bit unsigned numbers with **ONLY** 1-bit full adders and 2-to-1 multiplexers. In addition, the delay time of a 1-bit full adder and a 2-to-1 multiplexer are D_{FA} and D_{MX}, respectively. Moreover, D_{MX} is equal to $0.8*D_{FA}$. Please determine the minimum delay time for this carry-select adder.

7. (15pt) The following techniques have been developed for cache optimizations: hit time, miss rate or miss penalty: "Non-blocking cache", "multi-banked cache", and "critical word first and early restart". Please briefly explain these techniques and how they work.

8. (15pt) What are "3C cache misses"? List one technique to improve each of the 3C misses.

9. (10pt) Given the memory references (word addresses): 3, 180, 43, 2, 191, 88, 190, 14, 181, 44, 186, 253, and a direct-mapped cache with 10 blocks. Indicate which of the above 12 memory accesses will encounter a cache miss, if (1) each cache block has only 1 word, and (2) each cache block has 10 words.