



1. (10 points) Give an advantage that
  - (a) a sequential file has over an indexed file
  - (b) a sequential file has over a hashed file
  - (c) a indexed file has over a sequential file
  - (d) a indexed file has over a hashed file
  - (e) a hashed file has over a sequential
  - (f) a hashed file has over a indexed file
2. (10 points) Design an algorithm that lists all possible rearrangements of the symbols in a string of five distinct characters.
3. (10 points) Arrange the names Bi, Di, Ri, Si, Ti, and Wi in an order that requires the least number of comparisons when sorted by the quick sort algorithm.
4. (10 points) Describe what is the stored-program concept.
5. (10 points) Would a large array probably be passed to a subroutine by value? Yes or No? Support your judgment.
6. (10 points) Draw a state diagram and write the Turing instructions for a Turing machine that takes any string of 1s and changes every third 1 to a 0. Thus, for example,
 

...b111111b...

would become

...b110110b...
7. (15 points) Implement the combination logic  $F(A,B,C,D)=\Sigma(0,3,8,10,12,14)+d(1,2,5,7)$ 
  - (a) by using 3 level NAND gate (using minimal number of gates)
  - (b) by using a decoder
  - (c) by using a  $8 \times 1$  multiplexor.
8. (5 points) Describe the difference between syntax, run-time, and logic errors.
9. (20 points) Given the following list: 14,15,5,9,8,3,19,4
  - (a) Please construct a binary search tree for the sequence.
  - (b) Please traverse the binary search tree in postorder.
  - (c) Construct an AVL tree for the sequence.
  - (d) Construct a heap tree (note, the root has the maximum key) for the sequence.

(Note. Show your answers step by step.)



請依題號作答並將答案寫在答案卷上，違者不予計分。

題目1至題目10為多選題，每題5分。每題已暗示有幾個答案，但需全部答對才給分，答錯倒扣1分。

1. Which are privileged instructions? (2個答案)
  - (A) I/O instruction
  - (B) trap or software-generated interrupt
  - (C) WAIT instruction
  - (D) the base and limit registers (for memory space) loading
  
2. Which are correct for real-time systems? (3個答案)
  - (A) In hard real-time systems, the operating system kernel delays do not need to be bounded.
  - (B) A hard real-time system guarantees that critical tasks be completed on time.
  - (C) Virtual memory is almost never found on hard real-time systems.
  - (D) A soft real-time system claims that a critical real-time task gets priority over other tasks, and retains that priority until it completes.
  
3. Which activities should be taken in the secondary-storage management? (2個答案)
  - (A) free-space management
  - (B) creating and deleting directories
  - (C) storage allocation
  - (D) buffering
  
4. Which are correct for process states? (2個答案)
  - (A) If a process is created, it will enter the "running" state.
  - (B) If the waiting event of a process occurs, the process will enter the "running" state.
  - (C) If a running process executes I/O, it will enter the "waiting" state.
  - (D) If a running process encounters an interrupt, it will enter the "ready" state.
  
5. Which are correct for CPU-scheduling algorithms? (3個答案)
  - (A) The FCFS scheduling algorithm must be nonpreemptive.
  - (B) The SJF algorithm must be preemptive.
  - (C) An SJF algorithm is simply a priority algorithm where the priority is the inverse of the next CPU burst.
  - (D) The round-robin scheduling algorithm is designed especially for time-sharing systems.



6. Which are correct for process synchronizations? (3個答案)
- (A) A semaphore, apart from initialization, is accessed only through two standard atomic operations: wait and signal.
  - (B) Mutual-exclusion can be implemented with TestAndSet or Swap instructions.
  - (C) A spinlock (some kind of semaphores) is not useful when locks are expected to be held for short time.
  - (D) A counting semaphore can be implemented using binary semaphores.
7. What conditions does the approach (i.e., imposing a total ordering of all resource types, and requiring that each process requests resources in an increasing order of enumeration) try to prevent? (1個答案)
- (A) mutual exclusion
  - (B) circular wait
  - (C) no preemption
  - (D) hold and wait
8. Which are correct for pure segmentation? (3個答案)
- (A) Segmentation is a memory-management scheme that supports the user view of memory.
  - (B) A particular advantage of segmentation is the association of protection with the segment.
  - (C) An advantage of segmentation involves the sharing of code or data.
  - (D) Like paging, segmentation has no external fragmentation.
9. Which are correct for virtual memory? (2個答案)
- (A) FIFO page replacement is a stack algorithm.
  - (B) The LRU strategy is the optimal page-replacement algorithm looking backward in time, rather than forward.
  - (C) The accuracy of the working set depends on the selection of  $\Delta$  (i.e., the working-set window).
  - (D) If I/O is done to or from user virtual memory, these pages do not need to be locked in memory when demand paging is used.
10. Which disk scheduling algorithms always service I/O requests in only one direction? (1 個答案)
- (A) SSTF scheduling
  - (B) SCAN scheduling
  - (C) C-SCAN scheduling
  - (D) LOOK scheduling



11. The following code is designed to solve the Dining Philosopher Problem. Suppose that there are five philosophers spending their lives alternatively thinking and eating spaghetti, and they are seated around a table on which is placed five plates of pasta and five forks. When a philosopher decides to eat, then he or she must obtain two forks by first picking up the left fork and then picking up the right fork. After consuming food, the philosopher replaces the forks and resumes thinking. What problems would occur in the following code executed by each philosopher? Modify the code to solve the problems posed by you. (20%)

```
Semaphore fork [5] = {1, 1, 1, 1, 1};
```

```
Philosopher (int i) {
  While (True) {
    ... /* Thinking */
    P(fork[i]);          /* pick up left fork */
    P(fork[(i+1) mod 5]); /* pick up right fork */
    eat();
    V(fork[(i+1) mod 5]);
    V(fork[i]);
  }
}
```

12. Consider the following page reference string:

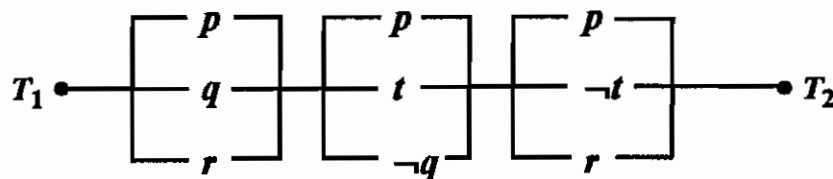
1, 2, 3, 4, 2, 1, 5, 6, 2, 1, 2, 3, 7, 6, 3, 2, 1, 2, 3, 6

How many page faults would occur for the following replacement algorithms: LRU replacement, FIFO replacement, Optimal replacement. Assuming the number of allocated frames is three and all frames are initially empty. (15%)

13. Consider the problem of jobs waiting in a queue until sufficient memory becomes available for them to be loaded and executed. If the queue is a simple first-in-first-out structure, then only the job at the head of the queue may be considered for placement in storage. On the other hand, with a more complex queuing mechanism, it might be possible to examine the entire queue to choose a job to be loaded and executed. Show how the latter discipline, even though more complex, might yield better throughput than the simple first-in-first-out strategy. (15%)



- (10 points) A gambler has designed two games. In the first game, he bets that in four rolls of a die, he can get at least one 3. In the second game, he bets that in 24 rolls of two dice, he can get at least a double 3. For each game, compute the probability that the gambler wins. For each game, do you think the gambler will win in the long run?
- (15 points) Construct a finite state machine that accepts any string in  $\{a,b\}^*$  whose number of a's is not divisible by 3 and whose number of b's is odd.
- (15 points) What is the cardinality of the power set of a set  $S$  in terms of the cardinality of  $S$ ? Demonstrate it with a few examples. Prove by mathematical induction that your formula is correct. Recall that the power set of any set  $A$  is the set of all subsets of  $A$ .
- (10 points) Triangle  $EFG$  is equilateral with  $EF=2$ . If five points are selected from the interior of the triangle, prove that there are at least two whose distance apart is less than 1.
- (10 points) A switching network is made up of wires and switches connecting two terminals  $T_1$  and  $T_2$ . Please substitute the following switching network by a simpler one.



- (10 points) For  $n \in \mathbf{Z}^+$ , prove that  $10^{2n} + 5 \times 12^n - 6$  can be divided by 22.
- (10 points) Consider the following program segment, where  $i, j$ , and  $k$  are integer variables. How many times is the **print** statement executed in this program segment?
 

```

      for i := 1 to 20 do
        for j := 1 to i do
          for k := 1 to j do
            print (i * j + k)
      
```
- (10 points) Draw a precedence graph for the following segment found at the start of a computer program:
 

(s1)	$a := 1$
(s2)	$b := 2$
(s3)	$a := a + 3$
(s4)	$c := b$
(s5)	$a := 2 * a - 1$
(s6)	$b := a * c$
(s7)	$c := 7$
(s8)	$d := c + 2$
- (10 points) Construct a Turing machine with tape symbols 0, 1, and  $B$  that, given a bit string as input, replaces all but the leftmost 1 on the tape with 0s and does not change any of the other symbols on the tape.