

National Tsing Hua University
Department of Computer Science
CS1356 -- Introduction to Information Engineering
Final Examination, Fall 2009

1. Answer true or false to the following statements with brief justifications. No credit will be given without correct justifications. (40 pt)
 - a. Any interactive system needs multiprogramming capability to provide real time response.
False: When there is only one iterative program running on a computer, the system need not have multiprogramming capability.
 - b. Encryption can prevent email spam.
False: Encryption can only protect information.
 - c. Semaphores are designed to prevent deadlock.
False: They are designed to protect critical regions.
 - d. When a computer is powered on, the program counter is assigned to a particular address in the BIOS.
True: This is how the booting process proceeds.
 - e. The advantage of using threads instead of processes is that running multi-thread need not switch context.
False: Using multi-thread still need switch context.
 - f. In the TCP/IP hierarchy, IP is the layer that reassembles messages as their pieces arrive at the destination.
False: Resembling message is the job for TCP or UDP.
 - g. There will be no hidden terminal problem in the wireless star network if the access point and nodes are placed in a space without any obstacles.
False: Distance could also cause hidden terminal problem.
 - h. Applications in the wireless environments better use the TCP protocol because it is more reliable.
False: The reliability of wireless environments is not taken cared by TCP. (different layers)
 - i. Videos in YouTube are contributed by users all over the world. Thus, viewing videos from YouTube follows a peer-to-peer model.
False: YouTube uses a client/server model for video sharing.
 - j. Messages cannot be relayed within the Internet forever.
True: Internet packets have counters to count the number of hopping, which is a finite number.

2. Alice and Bob both can access two bank accounts. Their bank account 1 has 100,000, and bank account 2 has 50,000. One day, both Alice and Bob need to withdraw 120,000 from those two bank accounts.
 - a. Explain the situation that a deadlock could happen when Alice and Bob want to withdraw money from those two bank accounts. (5pt)

Scenario: Alice withdraws 100000 from account 1 and Bob withdraws 50000 from account 2; and then Alice wants to withdraw 20000 from account 2 and Bob wants to withdraw 70000 from account 1 at the same time.

b · Give two *practical* methods that can prevent the deadlock happening, and explain which conditions of deadlock your methods attack. (5pt)

There are many methods. Here just name two.

(1) Bob asks Alice to deposit money back. (Allocated resource cannot be forcedly retrieved.)

(2) They get loan from bank. (Competition for non-sharable resources.)

3. In a network based on the bus topology, the bus is a non-shareable resource for which machines must compete to transmit messages. In a multitasking OS, we have two methods to resolve the competition of non-shareable resources: one is test-and-set; another is disable_interrupt/enable_interrupt. Can we use them to handle the competition of the bus? Why or why not? (5pt)

We cannot in general. For test-and-set, it works in the multitasking environment because it is atomic. But in the network, testing and then setting cannot prevent collisions because concurrent test-and-set can happen. For disable_interrupt/enable_interrupt, it works in multitasking OS because it prevents context switches. But for the bus network environments, the processes on different machines are really run in parallel.

**** There are time-sharing protocols, but they are beyond the scope of this class.**

4. In computer networking, “broadcast” refers to transmitting a packet to a group of devices on the network. Explain what’re the differences between broadcasting on Ethernet and broadcasting over an internet? (5pt)

Ethernet is a local area network. Broadcasting on Ethernet can be done in the link layer.

Broadcasting over an internet requires going through gateways and routers. It need be done in higher layers, such as in the application layer.

**** There is no Internet-wide broadcast.**

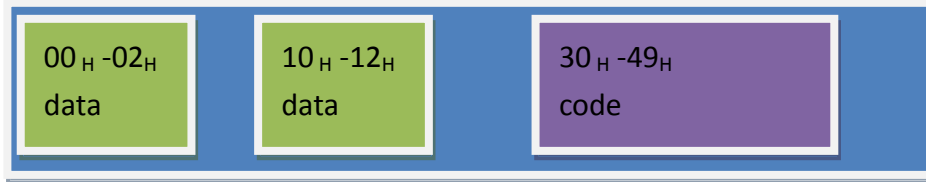
5. What does the Windows command “tracert” (In Linux/ Unix, it is called “traceroute” or “tracert”) do? (5pt)

“traceroute” is a computer network tool used to determine the route taken by packets across an IP network.

6. Why cannot the traditional telephone service provide conference calls? What is the fundamental difference between the traditional telephone line and the Internet? (5pt)

Telephone only has point-to-point communication, not many-to-many. Therefore it cannot provide conference calls. The fundamental difference is telephone service need to build a fixed connection before communication; while in the Internet, each packet (message) is routed dynamically and independently from source to destination.

7. Consider the program studied in Homework 3, as shown to the right.
- a. Draw its memory layout assuming that the program code starts at 30_H , indicating where the data are and where the code is in the memory. The machine language description table is given at the end. (5pt)



30 _H	2003
32 _H	2101
34 _H	2200
36 _H	2310
38 _H	1400
3A _H	3410
3C _H	5221
3E _H	5331
40 _H	3239
42 _H	333B
44 _H	B248
46 _H	B038
48 _H	C000

- b. In Homework 3, you need to rewrite the program when its stored address is changed from 30_H to $A0_H$. One of the advantages of using virtual memory is that when a program changes its loading address, its content need not be changed. Suppose a page is of size 16 bytes and the memory layout you obtained in (a) is the virtual memory of the program. When the program runs, the following table gives the virtual memory table for this process. You can see that the program code is now loaded at $A0_H$, but the code remains the same. Given this virtual memory mapping, when does OS need to do paging? (in executing which instruction) (5pt)

Page no.	Virtual address	Memory address
0	00 _H – 0F _H	D0 _H – DF _H
1	10 _H – 1F _H	C0 _H – CF _H
2	20 _H – 2F _H	In disk
3	30 _H – 3F _H	A0 _H – AF _H
4	40 _H – 4F _H	In disk
...

Paging happens when the instruction 3239 is executed, because this instruction is in the virtual memory space 40_H - 41_H , which is in disk, according to the table.

8. The following algorithm converts a decimal number to its binary representation.

Step 1.	Divide the value by two and record the remainder.
Step 2.	As long as the quotient obtained is not zero, continue to divide the newest quotient by two and record the remainder.
Step 3.	Now that a quotient of zero has been obtained, the binary representation of the original value consists of the remainders listed from right to left in the order they were recorded.

- a. What is the time complexity (operation count) to convert a number n (in decimal) to its binary representation using the above algorithm? (5pt)

$$O(\log_2(n))$$

- b、 This problem can be expressed using a recursive relation. (i) Show the recursive relation. (ii) What is the base case? (5pt)

Let $f(n)$ be the binary representation for the number n .

There recursive relation is $f(2n) = f(n) * 10_b$ and $f(2n+1) = f(n) * 10_b + 1$

The base case is $f(0) = 0$.

9. In designing a Role-Playing Game (RPG), we want to “simulate” n people walking on streets. The first thing to do is to “model” these people walking. A simple model is as follows. First, the time will be divided into small intervals, t_0, t_1, t_2, \dots . Second, at time t_i , each person will pick a random speed and a random direction to walk, and will keep the same speed and direction until t_{i+1} . The process is then repeated. Given the initial positions of the n people at time t_0 , we can “simulate” their walking and determine their positions at any time t_n .

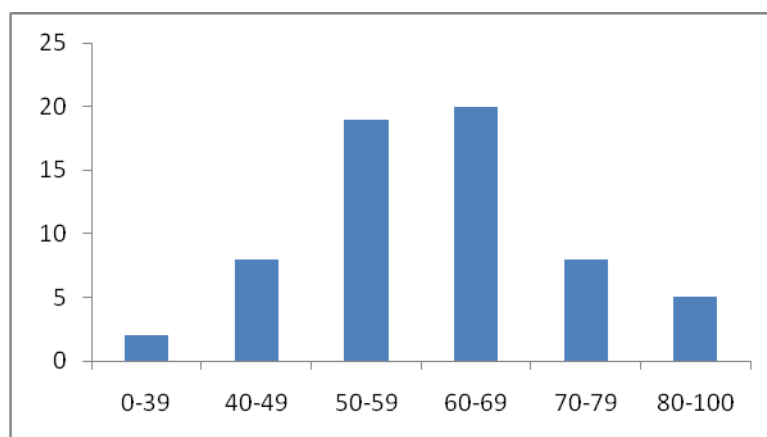
- a、 The above model captures the important characteristics of walking. But, people may walk, pause, and then walk again. Try to modify the above model to capture the characteristic of alternating walking and pausing. (5pt)

The model can be modified as follows. At time t_i , each person can decide (randomly) to walk or to pause. If he/she decides to walk, he/she will pick a random speed and a random direction to walk. If he/she decides to pause, he/she will stay where he/she is.

- b、 What are the similarities between simulating people walking and the first algorithm of the Josephus Problem? (Hint: Consider what the “state” of the Josephus Problem is at time t_0, t_i , and t_{i+1} , and what its “model” is.) (5pt)

Both of them capture the important features of the simulated objects and events. For RPG, the important features include how people move, their positions, moving speeds and directions, and whether pausing or walking. For the Josephus problem, the important features (state) are how many people are left, their relation in the circle (who is who’s next), and counting to whom currently.

** The machine language description table is omitted.



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