CS1356 Introduction to Information Engineering

2nd Midterm, 2010/11/29 (3 pages, 11 questions, ~~105~~ 125points)

1. True or False. For the false statements, give justifications. (~~20~~30pt)
   (a) An interactive process must be a real-time process.
   True
   (b) A process is the activity of executing a program.
   True
   (c) The test-and-set instruction is a deadlock avoidance method.
   False: test-and-set instruction is for mutual exclusion.
   (d) In a virtual memory system, the disk space needs be larger than the physical memory.
   False: no restriction of the size of disk space.
   (e) Context switch happens only when an interrupt triggered by timer or when a process is complete.
   False: it can happen at I/O.
   (f) The link layer and the network layer of the Internet software are used in a router.
   True:
   (g) Switch is essentially a bridge with multiple connections.
   True:
   (h) Ethernet uses IP address to locate a computer.
   False: It uses another addressing method.
   (i) The Internet can't function without domain name systems.
   False: It can function without domain name systems.
   (j) Hop count prevents a computer on the Internet to record copies of messages passing through it.
   False: nothing can prevent a computer on the Internet to record copies of messages passing through it.

2. Briefly explain the following terms (~~20~~30pt)
   (a) Context switch
   (b) Interrupt
   (c) Dispatcher
   (d) Semaphore
   (e) Paging
   (f) Hidden terminal problem

(g) CSMA/CD
(h) Routing
(i) Domain name
(j) Congestion control

(a) The procedure of changing from one process to another.
(b) When OS gets an interrupt, it will **preempt** the current process and check what is happened.
(c) When dispatcher get control, it selects the process from the process table
(d) A properly implemented flag that the task of testing and setting the flag cannot be split.
(e) Rotating programs and data back and forth between main memory and storage space on a magnetic disk.
(f) The signal drowns out different machines are blocked from each other by objects or distance even though they can all communicate with the central AP.
(g) Carrier Sense, Multiple Access with Collision Detection. When transmitting a message, machine will monitor the bus until bus become silence. If a clashing happened, both machines detect the clash and pause for a brief, independently random period of time before trying to transmit again.
(h) select a route to reach destination
(i) Every domain is assigned a mnemonic domain name, which is unique among all the domain names throughout the Internet.
(j) The sender can adjust its transmission rate to alleviate congestion.

3. In a multiprogramming system, a group of processes work on the same program, which uses a flag to protect the critical region, as shown in the figure above. (7pt)

```
/* flag can be accessed
   by all programs. */
while (flag != 0);
flag = 1;
/*critical region*/
flag =0;
```

(a) Why this code cannot guarantee mutual exclusion of the critical region?

It cannot guarantee the mutual exclusion because before the flag=1 statement, it can be context-switched to other program, which can enter to the critical region.

(b) Modify the code to achieve mutual exclusion.

```
/* flag can be accessed
   by all programs. */
while (test-and-set(flag));
flag = 1;
/*critical region*/
flag =0;
```

We only provide the method using test-and-set. The method using disable-interrupt and enable-interrupt is very complicated, which is beyond the scope of this class.

4. Assume that each of the following bit patterns originally had even parity. Which one(s) contains an error? (4pt)
   (a) 10111100 (b) 11010111 (c) 01010101 (d) 10001001
   (a) and (d)

5. The following is an error-correcting code of 8 symbols. Which symbol representations have Hamming distance 3 to the bit pattern 101101? (6pt)

Symbol	Representation	
A	000000	4
B	001111	2
C	010011	5
D	011100	3
E	100110	3
F	101001	1
G	110101	2
H	111010	4

   (D) and (E)

6. Students who want to enroll a class have to get the teacher's permission and to make payment. Both conditions can be achieved in any order. Suppose there is a class, of which the teacher only gives permission to 100 students, and the payment system only accepts the first 100 students. Suppose 99 students had enrolled to the class, and two more students want to take this course: one had had teacher's permission; another had made the payment. This is the situation of a

deadlock, which can be solved by the following ways. For each solution, which condition of deadlock is removed? (9pt)

(a) Both students are allowed to take this course.
Compete for non-sharable resources.

(b) Both students cannot be enrolled to this course.
Once the resource is allocated, it cannot be forcibly retrieved.

(c) Only the student made payment can take the course.
The resource is requested on a partial basis.
Or circular wait.

7. On a multiprogramming operating system OS1, a time slice of a task is 100 milliseconds (100×10^{-3}) and a context switch requires 10 milliseconds (10×10^{-3}). There are processes A, B, and C, which are started on OS1 at the same time and will be executed in the order A, B, C, A, B, C… and so on. The execution time for A, B, and C are 5 seconds, 1 second, and 20 seconds. How much time does each process take to be complete? (9pt)

A: 5/0.1 = 50 time slots
B: 1/0.1 = 10 time slots
C: 20/0.1= 200 time slots

We break the execution into 3 stages. The first stage has 3 tasks, so we define an execution block = 3*100+3*10=330. The second stage has 2 tasks, so the execution block is 2*100+2*10=220. The third stage has 1 task, so the execution block is 110.
Task B is only in the first stage: 330*9+100+10 = 3180
Task A is in the first stage and the second stage:
330*10+220*(49-10)+10 0= 11980
Task C is in the all stages: 330*10+220*50+110*(199-10-50)+100 = 28590

8. Suppose a subnet mask is `255.255.240.0`. Which IP addresses are in the same subnet? (5pt)
(a)`140.114.87.5` (b)`140.114.95.133`
(c)`140.115.87.62` (d)`140.114.63.2`

After the subnet masking,

(a) 140.114.87.5 AND 255.255.240.0=140.114.80.0

(b) 140.114.95.133AND 255.255.240.0=140.114.80.0

(c) 140.115.87.62 AND 255.255.240.0=140.115.80.0

(d) 140.114.63.2 AND 255.255.240.0=140.115.48.0

Only (a) and (b) are the same.

9. In a wireless network based on the star topology, the access point (AP) is a non-shareable resource which can only communicate with one machine at a time. (10pt)

   (a) Can the mechanisms used in multiprogramming systems for mutual exclusion be used to achieve the mutual exclusion of AP? Justify your answer.

   No, they cannot. A multiprogramming system uses flags(semaphore) to protect critical regions. But in a wireless network system, no central

   (b) Describe a scenario that can cause a deadlock even when the mutual exclusion of AP (no collision) is guaranteed.

   Machine A sends a request for communication to AP, and AP replies an acknowledgement. But this acknowledgement is lost for some reason. So machine A is waiting for the acknowledgement and the AP is waiting for A to send data.

10. An 8MB data is sent over a network whose bandwidth is 1Mbps. The data is first segmented into packets, each of size 1.6KB. (The last segment is allowed to be smaller than 1.6KB), and then a 32-byte header is appended to each packet. After that a parity bit is added to every byte of data before transmission. Assume there will be a bit error every 9K bits. For each error, it takes 10 milliseconds to fix. How long can the data be correctly transmitted? Represent your answer in milliseconds and use $1M=10^3K=10^6$. (5pt)

    8MB / 1.6K = 5000 segments

    Each segment has an header of 32-byte

    ➔ Total message size = 8MB+5000*32-byte = 8160KB

Every byte adds a parity bit ➔ 8160K bits is added
➔ Total message size = 8160KB + 8160K bits = 9*8160K bits= 73440 Kbits
Sending 9*8160K bits over the network (1Mbps) needs 73440 ms
However, every 9K bits, there is an error, which takes 10ms to handle.
There are total 8160 errors, so it takes 81600ms to fix errors.
The time to complete the transmission is 73440 ms+81600ms = 155040ms.

11. We can say that computer networks virtualize physical links because in traditional telephone systems, each physical link is used just for one phone call, but a physical links can be shared by multiple pairs of connections in computer networks and each connection is almost as smooth as it occupies the entire link. (10pt)

(a) Name the major mechanisms in the Internet protocols that make physical link virtualization possible.

In the link layer, collision avoidance or collision detection.
In the network layer, IP address and routing protocol.
In the transport layer, message segmentation (packet).

(b) The multiprogramming in OS virtualizes computer resources for multiple processes. Design a protocol for a bus topology network that mimics the mechanism of the multiprogramming to allow multiple pairs of machines, connected to the same bus, communicating “simultaneously”.

The basic idea of multiprogramming is round-robin time-sharing. So the protocol will be like: Each machine has its own time slots, and it is only allowed to send during its time slots. And all machines take turns to send. For a more complete design, a master machine, such as gateway, is needed for machine registration and time slot assignment.