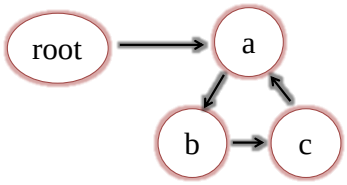
# 長庚大學111學年度第二學期作業系統實務期中測驗(總分108)

<<請依題號順序作答，跳號作答不予計分，跳號作答不予計分，跳號作答不予計分>>

系級: 姓名: 學號:

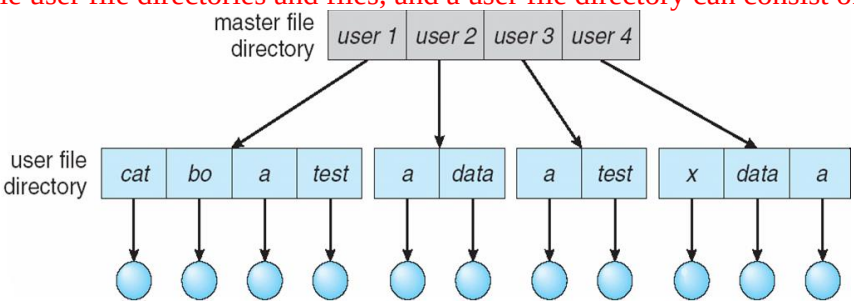
1. (8%) Directory designs are an important issue in file systems. (a) What is the difference between Tree-Structured Directories and Acyclic-Graph Directories? If we extend the Acyclic-Graph Directory design to General Graph Directories, we might have some file and directory structure as the following figure. (b) What is the problem if we remove "/root/a"?



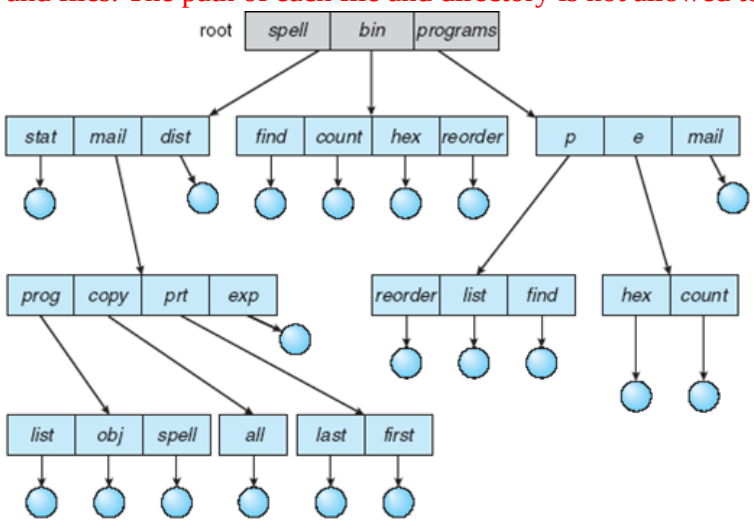

Answer: (a) Based on a tree structure, Acyclic-Graph Directories further allows the sharing of files without having any cycle in the directory structure.
(b) There is a self-referencing cycle among directories a, b and c. Thus, even though there is no path for accessing a, b or c, directories a, b and c are still not removed.

2. (8%) For the directory design in file system, please define what are the (a) **Two-Level Directory** design and the (b) **Tree-Structured Directory** design. You can draw some diagrams to explain them.

Answer: (a) Two-Level Directory: There are two levels of directories. A master file directory can consist of multiple user file directories and files, and a user file directory can consist of multiple files.




(b) Tree-Structured Directory: Based on a tree structure, each directory might have its subdirectories and files. The path of each file and directory is not allowed to form a circle.



3. (18%) Let's have some case study on the **Hard Link** and the **Symbolic Link**. We do the following operations with the specified order.
   (1) Create a file /dir1/file1
   (2) Create a symbolic link /dir2/file2 to the file /dir1/file1
   (3) Create a hard link /dir3/file3 to the file /dir1/file1
   (4) Create a symbolic link /dir4/file4 to the file /dir3/file3

   Now, let's consider three individual cases:

   Case 1: If /dir2/file2 is removed, can we access the file by the entries (a) /dir1/file1, (b) /dir3/file3, and (c) /dir4/file4? You must provide some reasons to support your answers.

   Case 2: If /dir1/file1 is removed, can we access the file by the entries (d) /dir2/file2, (e) /dir3/file3, and (f) /dir4/file4? You must provide some reasons to support your answers.

   Case 3: If /dir3/file3 is removed, can we access the file by the entries (g) /dir1/file1, (h) /dir2/file2, and (i) /dir4/file4? You must provide some reasons to support your answers.

   Answer: (a) yes, it is a hard link to the file
   (b) yes, it is a hard link to the file
   (c) yes, it is a symbolic link to /dir3/file3, and /dir3/file3 exists
   (d) no, it is a symbolic link to /dir1/file1, and /dir1/file1 does not exist
   (e) yes, it is a hard link
   (f) yes, it is a symbolic link to /dir3/file3, and /dir3/file3 exists
   (g) yes, it is a hard link
   (h) yes, it is a symbolic link to /dir1/file1, and /dir1/file1 exists
   (i) no, it is a symbolic link to /dir3/file3, and /dir3/file3 does not exist

4. (8%) There are three basic methods of file allocation, i.e., Contiguous Allocation, Linked Allocation, and Indexed Allocation. (a) Please answer that the FAT file system is developed on which type of allocation? (b) How does FAT do to reduce the cost of random reads and writes?

   Answer: (a) Basically, FAT is a kind of linked allocation.
   (b) FAT separates the pointers of linked lists and the data in two different areas. The pointers are collected in the file allocation table for quickly finding out all pointers of a linked list.

5. (8%) In an operating system, there could be multiple file systems and a Virtual File System (VFS). Why do we need a VFS for using the file systems in our operating system?

   Answer: For user applications, VFS provides a consistent interface to access files in different file systems. For different file systems, VFS recognize the different functions provided by different file system to translate the user requests to native file system operations.

6. (12%) Considering the disk scheduling, let a disk drive consist of 100 cylinders, from cylinder 0 to cylinder 99. Assume that the read-write head is now at cylinder 20 and moving toward cylinder 99. Now, there are multiple read/write requests (to be served) in the disk I/O queue, and no more request will arrive. The queued requests are at the following cylinders: 7, 14, 16, 21, 29, 58, 74, 92. Please illustrate the scheduling results of (a) the SSTF scheduling, (b) the SCAN scheduling, and (c) the C-LOOK scheduling.

   Answer: SSTF: 21, 16, 14, 7, 29, 58, 74, 92
   SCAN: 21, 29, 58, 74, 92, (99), 16, 14, 7
   C-LOOK: 21, 29, 58, 74, 92, 7, 14, 16

7. (12%) Please explain (a) **RAID 1**. Assume we use two disks to run a RAID 1, where for each disk, the mean time to failure is 10,000 hours, and the mean time to repair is 100 hours. (b) Please derive the mean time to data loss. (c) Based on RAID 1, if we want to improve not only the reliability but also the performance, we can do RAID 1+0. Please explain **RAID 1+0**.

Answer: (a) Mirroring or shadowing keeps duplicate of each disk
(b) Mean time to failure of any of the two disks: 10,000/2 = 5,000
The possibility for another disk to fail within the 100 hours: 100/10,000 = 1/100
Mean time to data loss is 5,000 / (1/100) = 500,000 hours
(c) For each disk, another disk is used to do the RAID 1 mirroring.
Several RAID 1 volumes are used together for RAID 0 data striping.

8. (8%) Please explain the difference between **Buffering**, and **Spooling**.
Answer: Buffering — store data in memory while transferring between devices
Spooling — holds multiple buffers for a device that cannot accept interleaved data streams

9. (8%) There four type of device registers which can be accessed by the host to control the device: data-in registers, data-out registers, status registers, and control registers. Please explain the usage of (a) status registers and (b) control registers.
Answer: (a) The status register contains bits which indicate device states.
(b) The control register is written by the host to send commands.

10. (8%) There are several security violation methods. Please explain (a) Man-in-the-middle attack and (b) Session hijacking.
Answer: (a) Man-in-the-middle attack: Intruder sits in data flow, masquerading as sender to receiver and vice versa
(b) Session hijacking: Intercept an already-established session to bypass authentication

11. (10%) Assume that there are a public key $K_e$ and a private key $K_d$, where $K_e$ and $K_d$ are a pair. E(key, data) and D(key, ciphertext) are the encryption and decryption functions, respectively. E($K_e$, X) is the encryption result of any data X by using function E() with key $K_e$, and D($K_d$, Y) is the decryption result of any ciphertext Y by using function D() with key $K_d$. Now, let Emilly have key $K_e$, and David have key $K_d$. If Emilly wants to send some private data Q to David. It is very easy. Emilly just needs to encrypt the data as E($K_e$, Q) and send it to David. David can then run the decryption function D($K_d$, E($K_e$, Q)) to get the data Q. Let's further consider symmetric encryption/decryption technique. We also denote the symmetric encryption and decryption functions by E(key, data) and D(key, ciphertext), respectively. Now, if David wants to send some private data R to Emilly, what should they do? (Hint: First, Emily has to creates a symmetric key, and let the symmetric key be Z.)
Answer: 1. Emily creates a key $Z$
2. Emily sends E($K_e$, $Z$) to David
3. David calls D($K_d$, E($K_e$, $Z$)) to get key $Z$
4. David sends E($Z$, R) to Emily
5. Emily calls D($Z$, E($Z$, $R$)) to get data R